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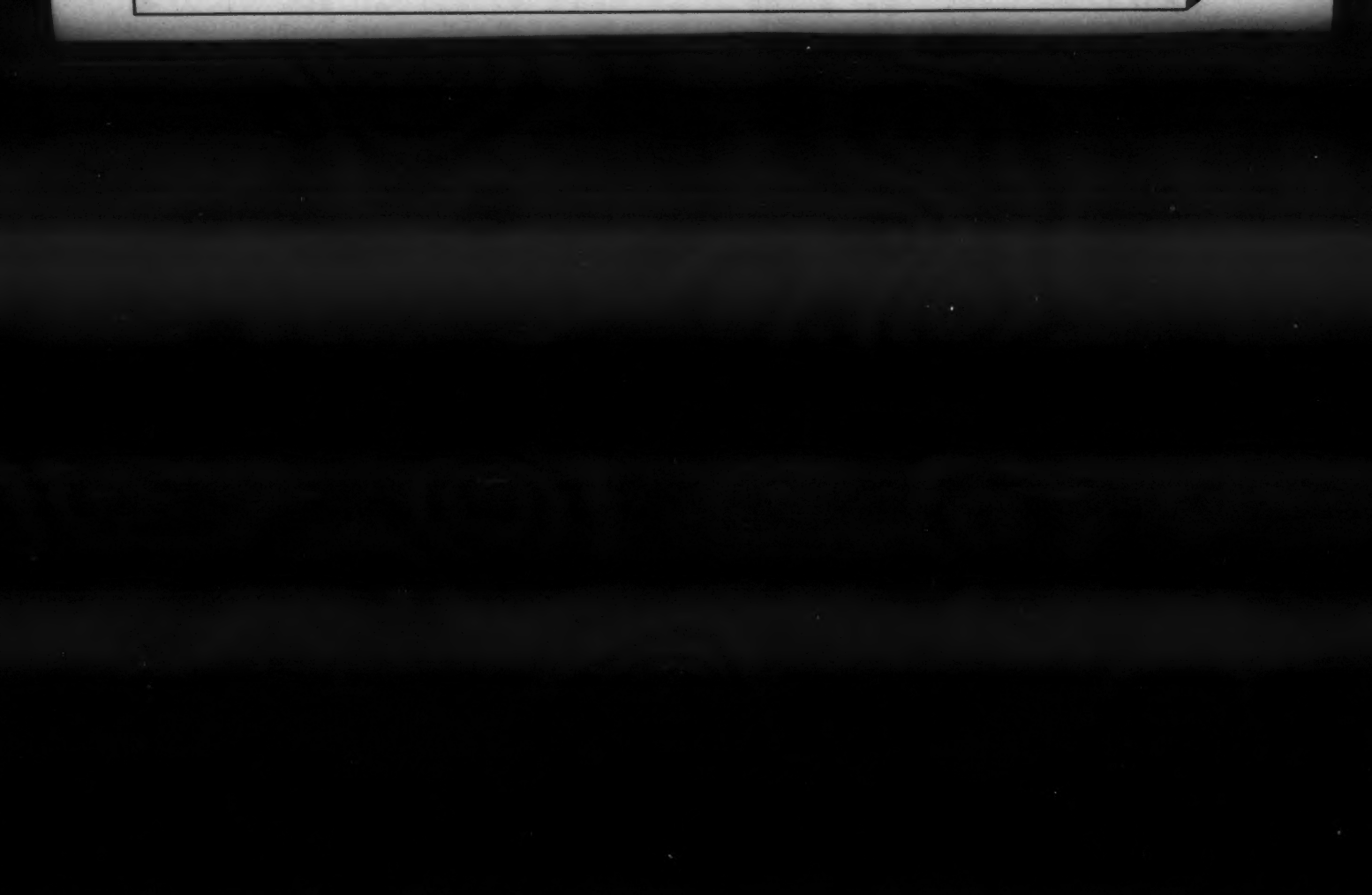

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TABLE OF CONTENTS

Research Costs in Educational Institutions. E. L. Moreland, Vice President 247
Engineering Defense Training Begins. Roy A. Seaton 249
The University of Michigan. J. Raleigh Nelson 254
Engineering Enrollments, 1940–41 264
48th Annual Meeting:
Report of Conferences 279
Round Table—Aims and Scope of Engineering Curricula:
Introduction. H. J. Gilkey 322
Social-Humanistic Aspects of the Curriculum. R. E. Doherty..... 326
A Detached Critical Analysis of the Report. Franklin Thomas. 332
Technical Aspects of the Curriculum. H. E. Wessman 335
Integrated vs. Stratified Curriculum. E. L. Moreland 338
Are Recommendations of this Report Compatible with a Four-Year Curriculum? Ivan C. Crawford 342
Plea for a Liberal Four-Year Engineering Curriculum. P. T. Norton 343
Questions and Answers 345
The Modern Hospital and Its Technological Staff. H. N. Walker 358
Sections and Branches:
Allegheny 362
New England 364
Mechanical Engineering Page 368
Tentative Outline of Conference for Mechanical Engineering Teachers 369
Engineers' Council for Professional Development 370
New Members 371
College Notes 372
Summer Session Conference on English and Speech 374
Book Reviews 375

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RESEARCH COSTS IN EDUCATIONAL INSTITUTIONS

By EDWARD L. MORELAND

Vice President of the Society

Participation by educational institutions in programs of research and instruction related to National Defense has posed some interesting and complex problems of educational costs. One of these is a method of arriving at a charge for research which is fair to both institution and sponsor. Since many institutions are now undertaking a greater volume of outside research than ever before, it may be mutually helpful to outline some of the elements of the problem in an effort to rationalize it.

The costs entering into research may be grouped under four main headings; labor, materials, equipment, and overhead or undistributed costs.

Materials and equipment may be clearly defined, but what should be included in labor costs and what is overhead? Direct labor costs are easy to determine but to what extent should supervisory services be charged—the part-time services, for example, of a senior professor who may be directing a project? Should such supervisory cost be included with the direct labor costs, or should it be defined as part of the overhead cost and allowed for in that item?

A proper determination of labor costs is doubly important since overhead is usually expressed as a percentage of labor costs. This is done because material, equipment and incidental expenses vary greatly with the research, whereas the expense for services of personnel engaged on the work provides at least an approximate measure of the contribution of the research organization. The cost of technical supervision of a research contract may be included as a part of the labor cost, or it may be included in the overhead but, in any case, it must not be overlooked. Obviously the basis on which the overhead percentage is determined must be consistent with the way in which it is applied.

The chief factor in research overhead is the operating overhead of the institution as a whole, including administrative expense, plant maintenance and operation, power, space, and other service costs. Interest on investment, at least in certain types of institutions, and obsolescence and depreciation of equipment are two other factors which should be considered and which educational in-

stitutions frequently overlook. Obsolescence in scientific equipment may be rapid, and depreciation may be accelerated by the exigencies of special research.

Of these three elements, all expressed in terms of labor costs, the basic and most important is the operating overhead. While institutions may waive other overhead costs without serious detriment, if they ignore operating overhead they cannot normally conduct research for outside organizations on any significant scale without throwing a financial burden on the educational program.

Many institutions take into consideration the objectives and nature of the project when fixing the overhead to be charged in each particular case. The overhead charge for government and other non-commercial research might, for example, include only operating overhead, whereas a research solely for the benefit of a commercial organization might be assigned the full overhead which usually is approximately twice the basic operating overhead. There are situations where projects may be taken on an incremental basis, with a resultant decrease in overhead, or where the research has an educational value that warrants it being undertaken at little or no overhead. Generally speaking, however, at least the operating overhead, as defined above, must be assessed if the institution expects to carry on any large volume of research without ultimate drain on its resources.

Many other elements enter into this cost picture, and only enough have been suggested to outline the problem. Chiefly important is the need of each institution to know what its costs are; when it does, it may more intelligently and justly handle each project which comes to it. It will not overcharge nor will it rob its educational program or draw upon tuition funds for programs which should be wholly supported by outside agencies.

That the element of overhead must be included in any accurate determination of costs has long been recognized by commercial laboratories and consulting firms, and that it is proper and necessary for educational institutions has been recognized by various government agencies sponsoring research, notably the National Defense Research Committee. The problem for educational institutions is more than an elementary accounting problem; it involves questions of public service, of educational policy and of administrative and fiduciary responsibility. Educational institutions can well study this problem for much still remains to be clarified.

ENGINEERING DEFENSE TRAINING BEGINS

By ROY A. SEATON

Director, Engineering Defense Training, U. S. Office of Education

The November, 1940 issue of the JOURNAL OF ENGINEERING EDUCATION reproduced a letter sent by John W. Studebaker, U. S. Commissioner of Education, to the presidents of American engineering colleges requesting their coöperation in establishing short, intensive engineering courses of college grade to prepare students for technical and supervisory positions with the industries and Federal agencies concerned with national defense. The organization and procedures necessary for securing prompt action were also explained briefly.

The engineering schools have risen to the emergency splendidly. As this issue of the JOURNAL goes to press, they have already submitted to the Office of Education more than 400 proposals for specific courses for defense workers. Approximately two-thirds of these have already been approved and the institutions have been authorized to begin instruction as promptly as is feasible. Approval of many of the remaining courses will be issued as soon as it is possible to clear up certain details, such as the existence of a definite defense need for the type of training proposed, or the availability of suitable equipment or of qualified instructors. Meanwhile, additional proposals are being received in every mail.

In considering each proposal Commissioner Studebaker is leaning heavily upon the opinions of his advisory committee, which is composed of eleven men thoroughly familiar with the entire field of engineering education. A. A. Potter, Dean, Schools of Engineering, Purdue University, and Past President of the S. P. E. E., is chairman of this committee. Other members are F. L. Bishop, Secretary of the S. P. E. E.; R. E. Doherty, President, Carnegie Institute of Technology; Gibb Gilchrist, Dean of Engineering, A. and M. College of Texas; H. P. Hammond, Dean of Engineering, Pennsylvania State College and Past President of the S. P. E. E.; W. O. Hotchkiss, President, Rensselaer Polytechnic Institute; R. S. McBride, Consulting Engineer, Washington, D. C.; Thorndike Saville, Dean of Engineering, New York University; C. C. Williams, President, Lehigh University and Past President of the S. P. E. E.; B. M. Woods, Past Chairman, Department of Mechanical

Engineering, University of California; and Allen W. Horton, Jr. (secretary).

Approval of a proposal is given when it has been clearly determined that a definite defense need exists for the workers to be trained, that the sponsoring institution has the experience, staff, and facilities needed to give suitable instruction at a reasonable cost, and that properly qualified students are probably available in sufficient numbers. If, after approval of the proposal, an adequate number of students do not enroll, provision is made for the cancellation of the course without financial loss to the institution.

Prospective students must satisfy the school giving the course that they have the requisite basic training and experience to understand the subject and that they are employable in defense work. Whether or not they are currently employed is immaterial, except that they must, of course, be free to attend classes at the times set for instruction. Many of the courses will be given at night, and in temporary quarters away from the campuses, in order to meet the convenience of persons already employed during the day.

Proposals that have been approved cover a wide range, from such standard courses as engineering drawing, machine design, and testing materials, to special courses designed to fill a specific need for a particular group of men in a specialized industry. Massachusetts Institute of Technology, for example, is to give a course designed specifically to supplement the training in ordnance inspection being given by Watertown Arsenal.

Costs incurred by the participating institutions in giving these courses will be paid from an appropriation of $9,000,000 included in the supplementary defense appropriation act approved by President Roosevelt on October 9th. Thus it will be unnecessary to require students to pay tuition charges or laboratory fees. No provision is made in the act, however, for the subsistence of students while they are attending the course, and they will be expected to purchase their own textbooks.

Administration of the Engineering Defense Training program in the Office of Education has been placed in the hands of a special staff assembled for the purpose, several members of which were "drafted" from engineering colleges. This staff reports to Commissioner Studebaker through Dr. Fred J. Kelly, Chief of the Division of Higher Education.

The writer was taken from Kansas State College to serve as Director of the program. Dean George W. Case, of the University of New Hampshire, is responsible for the content of approved courses and the analysis of proposals; Allen W. Horton, Jr., former assistant to President Karl T. Compton of the Massachusetts Institute of Technology and currently on leave from the Standard

Oil Company of California, is serving as Administrative Assistant. Robert B. Garrabrant, recently associated with American Engineering Council, is handling publicity, information, and records. Accounting procedures are being worked out by J. Harvey Cain, formerly Director of the Financial Advisory Service of the American Council on Education and now on the staff of an auditing firm in New York City.

Relations with engineering schools in all sections of the country are being facilitated by 22 non-paid regional advisers (see list below) who assist the engineering schools to determine training needs and to plan courses to meet these needs. Whenever needs exceed facilities or available students, as is usually true in the industrial regions, the regional adviser reports this fact to Washington, so that deficiencies may be met by the establishment of suitable courses in other regions. In this way a coördinated national program is being developed that will, it is hoped, provide needed personnel with special engineering training of college grade without creating an over-supply for any particular type of service.

The procedure to be followed by participating institutions is summarized in the following steps:

1. Determine the need of defense industries and Federal defense agencies for specially trained personnel, either locally, through the regional adviser, or on advice from the Office of Education.

2. Determine whether an adequate number of qualified students are probably available, and the maximum, minimum, and desired number that can be trained by the institution.

3. Plan a course to give the required training at a time and place that will meet the needs of the students, and prepare an estimated-cost budget.

4. Submit a preliminary proposal for the course to the Office of Education for its consideration in relation to the national plan. (Forms are available for this purpose.)

5. Upon approval, enroll students and, if the number enrolled is not less than the minimum for which approval has been given, begin the instruction.

6. After two weeks of instruction, submit to the Office of Education a revised proposal and estimated-cost budget, based upon the number of students actually taking the course.

All expenditures are to be made under the rules normally followed by the school in spending its own funds. Periodic reports, both educational and financial, are to be made as required, on forms to be supplied by the Commissioner of Education.

While the Engineering Defense Training program is now well started, it is hoped that many more institutions will participate, and that those already taking part will continue to submit proposals

as new defense needs are discovered. The engineering schools must meet this sudden and expanding demand for special training along technical lines, if it is to be met, for they are the only institutions that can do the job promptly—and speed is essential. Participation is both an obligation and an opportunity to make a substantial contribution to preparation for national defense.

ENGINEERING DEFENSE TRAINING

Regions and Regional Advisers

Regional Adviser	Address	Area for Supervision	Region Number
E. L. Moreland	Dean of Engineering M. I. T. Cambridge, Mass.	Maine, Mass., New Hampshire, Vermont	1
L. E. Seeley	Assoc. Prof. of Mech. Eng. Yale University New Haven, Conn.	Connecticut and Rhode Island	2
S. C. Hollister	Dean, College of Eng. Cornell University Ithaca, New York	New York State (except New York City area)	3
J. W. Barker	Dean, Faculty of Eng. Columbia University New York, N. Y.	New York City and Long Island	4
A. R. Cullimore	President, Newark College of Engineering Newark, New Jersey	Northern New Jersey	5
W. T. Spivey	Director, Evening School Drexel Institute of Technology Philadelphia, Pa.	Eastern Penn., Southern New Jersey, and Delaware	6
S. S. Steinberg	Dean, College of Eng. Univ. of Maryland College Park, Md.	District of Columbia and Eastern Maryland	7
Blake R. Van Leer	Dean, College of Eng. N. C. State College Raleigh, N. C.	North Carolina, South Carolina and Virginia	8
J. E. McDaniel	Prof. and Director of Cooperative Courses Georgia School of Tech. Atlanta, Georgia	Alabama, Florida, Georgia, Mississippi, Eastern Tennessee	9
F. L. Wilkinson, Jr.	Dean, Speed Scientific School Univ. of Louisville Louisville, Ky.	Kentucky, Southern Ohio	10
J. D. Beatty	Carnegie Institute of Technology Pittsburgh, Pa.	Western Pennsylvania, West Virginia, Western Maryland	11
C. E. MacQuigg	Dean of Engineering Col. Ohio State University Columbus, Ohio	Northern Ohio	12
H. B. Dirks	Dean of Engineering Mich. State College Lansing, Michigan	Southern Michigan	13
D. B. Prentice	President, Rose Polytechnic Institute Terre Haute, Ind.	Indiana (except for Chicago industrial area)	14

Regional Adviser	Address	Area for Supervision	Region Number
H. T. Heald	President Illinois Inst. of Tech. Chicago, Illinois	Illinois, Southern Wisc., and the Chicago industrial area in Indiana	15
H. O. Croft	Head, Dept. of Mech. Engineering Univ. of Iowa Iowa City, Iowa	Iowa, Minnesota, Nebraska, North Dakota, South Dakota, Northern Wisc., and Northern Michigan	16
A. S. Langsdorf	Dean, School of Eng. Washington University St. Louis, Missouri	Arkansas, Kansas, Missouri, Oklahoma, Western Tenn.	17
W. R. Woolrich	Dean of Engineering Univ. of Texas Austin, Texas	Louisiana and Texas (East of Pecos River)	18
M. F. Coolbaugh	President Colo. School of Mines Golden, Colorado	Colorado and Wyoming	19
R. L. Daugherty	Prof. of Mech. Eng. Cal. Inst. of Tech. Pasadena, California	Ariz., New Mexico, Southern Cal., and Texas (West of Pecos River)	20
S. B. Morris	Dean, School of Eng. Stanford Univ. Stanford Univ., Cal.	Northern Cal., Nevada and Utah	21
H. H. Langdon	Head, Dept. of Mech. Engineering State College of Washington Pullman, Washington	Idaho, Montana, Oregon and Washington	22

THE UNIVERSITY OF MICHIGAN

By J. RALEIGH NELSON *

Members of the Society for the Promotion of Engineering Education who come to Ann Arbor for the annual meeting of the Society, June 23 to 27, will find Ann Arbor greatly changed since they were here in 1920. They will see a pioneer institution, great because of its leadership in the field of state-supported education, in the process of becoming an impressive institution also in its physical aspects. A tremendous expansion of plant has been made possible during these twenty years not only by the continued pride of the Commonwealth in its university, but by the generosity of its alumni.

The University, founded in 1817 in the very depths of the wilderness, may well claim to have been the pioneer institution of the great new country west of the Alleghenies. With courage and vision, in the true spirit of a pioneer, it blazed its way for many important new movements in education. Here, under its guidance, was developed the first state system of public instruction, headed by a state superintendent and organically related to the University itself. The plan of admitting students from accredited high schools by diploma, which it originated, placed it as the keystone of the entire system. It represented an entirely new conception of a state-supported institution. As President James R. Angell of Yale has said in commenting on the contribution of his great father: "The progress of the state university movement in the upper Mississippi Valley region, which constitutes such a miraculous chapter in American educational history, would have been long delayed save for the contagious example of Michigan."

In many other things of fundamental value it was an innovator. It was the first institution to have an elective board of regents, and to be financed by a tax levied on a certain proportion of all assessed property; it had the first departments of astronomy, of history, and of bacteriology, west of the Alleghenies, the first chair of the science and art of teaching, the first school of forestry, the first

* Professor Nelson was a member of the engineering faculty of the University of Michigan for thirty-two years. He was Chairman of the Department of English until he resigned in February, 1936, to become Counselor to Foreign Students and Director of the International Center. He was a member of the S. P. E. E. from 1914 to 1937, and Chairman of the Committee on English from 1921 to 1928.

THE EAST ENGINEERING BUILDING

school of political science; it was the first large university to admit women, the first to establish the seminar method of instruction, and the first to develop a true graduate curriculum. Springing up from the very soil of a pioneer community, its founders untrammelled in their thinking by conventional standards, it adventured and experimented quite independently with what at the time must have seemed impossible idealism.

The University of Michigan has always received full recognition as the first of a new type of institution,—in a sense the mother of the state institutions of the Middle West and West; but, up to the end of the World War, its building program had lagged far behind its academic achievement. Members of the S. P. E. E. who have not visited Ann Arbor since the meeting of the Society in 1920 will hardly recognize the Michigan Campus today. The building program which has transformed it so completely had, to be sure, even by 1920 added the Michigan Union, the Hill Auditorium, the Alumni Memorial Hall, the Library, and several greatly needed departmental buildings; but the period of physical expansion which is still in progress received its greatest impetus from the brief, but vigorous, administration of President Leroy Burton. In a single year, he secured $5,000,000 from the State Legislature for new buildings, as well as several large gifts from private donors, including the Law Quadrangle, and he proposed a ten-year building program of $18,000,000. The momentum of this great building program has never slackened. During President Ruthven's administration, expansions of the physical plant have aggregated somewhere near $10,000,000.

At the present time the University is engaged in improving its housing facilities. Three years ago only about 300 men students were in dormitories: today approximately 1800 are housed in the beautiful East and West Quadrangles. During the same three-year period, the women's dormitories, which had already reached a capacity of about 800, have been increased to care for approximately 1200. With only a quarter of its 12,000 students in dormitories, however, the University is evidently only fairly started on its housing program. Its plans for the future will be based on its experience with these first units.

In all these projects, as well as in the development of its many educational enterprises, the University has not only been generously supported by the State, but has received many gifts from its alumni and other donors. Probably no other state university has had such generous support from its former students. Of the $10,000,000 spent on extensions of plant in the first ten years of President Ruthven's administration, only one-third came from state and

THE WEST ENGINEERING BUILDING

federal funds. It is estimated that from its founding in 1817 up to 1940, the sum total of these gifts is approximately $44,000,000; of this amount $23,000,000 has come from Michigan alumni. Michigan was the first of all American universities to appoint a full-time alumni secretary. The dictum of its great president, James B. Angell, to the alumni has always been taken seriously: "In a very just sense and in a very large degree the fortunes of the University are committed to your hands." Apparently it has paid to heed these wise words of the beloved doctor.

The Michigan Campus has spread from its original 40-acre pasture lot out toward the Huron River on the north, out toward Pittsfield and Ypsilanti on the south, and has fairly engulfed the surrounding sections of the city and stretched out into the far corners of the world. It has come to include the Biological Station on Douglass Lake, the Forestry Camp on Lake Superior, the Engineering Camp in Wyoming, and even the Lamont-Hussey Observatory in Bloemfontein in South Africa. Obviously, no one coming to Ann Arbor for a three-day conference can do more than get a general idea of the extent of its growth. No one will care to make even a general inspection of all the new buildings. No one should, however, miss seeing the Horace H. Rackham School of Graduate Studies, a gift of $2,000,000, or the Law Quadrangle, a $5,000,000 gift from a distinguished alumnus, William W. Cook, of New York, or the Clements Library, or the Burton Memorial Tower with its Baird Carillon. The new dormitories represent such intelligent and skillful planning that they also will undoubtedly be of interest to many. After all, the interest for our S. P. E. E. visitors lies largely in the spectacle of a great institution meeting its problems of expansion largely by the support of its alumni body.

The College of Engineering, which is to be host to the Society this year, became an independent unit of the University in 1895 with Charles E. Greene as its first dean. Technical courses in engineering were given, however, in the Literary Department as early as 1853 and developed after the coming of De Volson Wood in 1857 into a systematized course in engineering. Michigan was thus the sixth institution in this country to offer such a course. It was, however, the first strictly public institution supported by state funds to offer a systematic curriculum in engineering recognized as on an equal footing with the classical course. From the beginning the College of Engineering was fortunate in its leadership. De Volson Wood was one of the best known engineering educators of his time, a really great teacher. Dean Cooley in his reminiscences remarks that it could be said of him as was said by Dr.

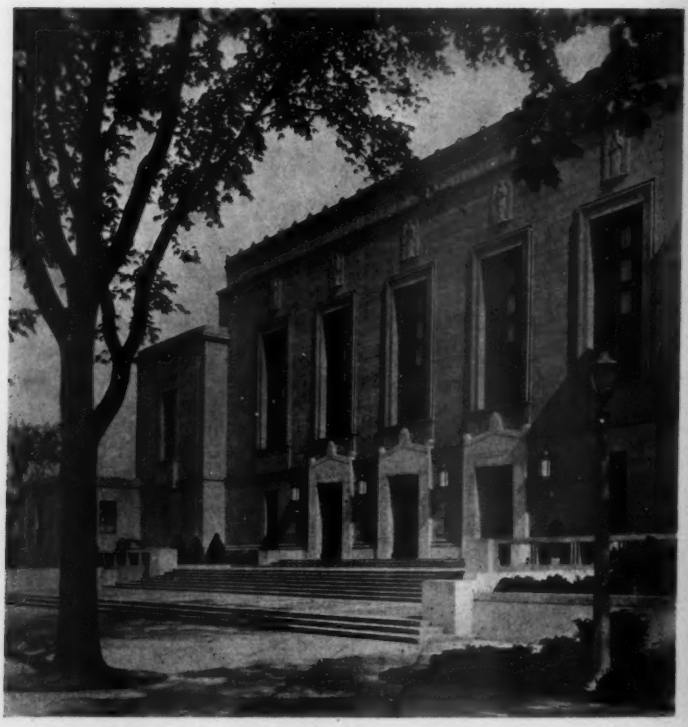
Angell in 1887 of President Tappan: "Not even yet have we filled in the sketch he drew for an ideal university for Michigan."

The triumvirate which in 1872 carried forward the work so ably initiated by De Volson Wood was a strange association of

THE ENTRANCE TO THE MICHIGAN UNION

personalities; Charles Ezra Greene, so austerely and elegantly the New England Puritan; Joseph B. Davis, the embodyment of the homely virtues of the Midwestern frontier; and Charles Simeon Dennison, the perfect Beau Brummel of a man. Surely no two

teachers were ever more beloved than Davis and Dennison and none more respected than C. E. Greene. When, in 1881, Mortimer E. Cooley was detailed by the United States Navy to act as Professor of Steam Engineering and Naval Architecture, there entered upon the scene a dynamic personality whose influence is still powerfully felt. Professor Cooley in 1881 erected the first little frame



HORACE H. RACKHAM SCHOOL OF GRADUATE STUDIES

laboratory at Michigan at a cost of $1500; he has lived to see the great buildings of the present plant, to help plan the projected million dollar engineering research building and to see the establishment, by his former students, of the Mortimer E. Cooley Foundation for the encouragement of engineering research. His life span has already comprehended almost the entire history of the College; when his autobiography is published, as it is hoped it

may be soon, it will be a compendium of information on the significant movements in engineering education through its most formative period.

Dean Cooley, now well in his eighties, is still incomparably the most impressive figure on the Campus as he swings down East University Avenue to his office with his grand military air; his steps a trifle uncertain, but his figure erect, his head held high, he still looks the admiral of the fleet. His old friends in S. P. E. E. will be glad to know that he will be here to greet them.

The fifth and present dean of the Engineering College, Ivan Charles Crawford, who entered on his duties in July 1940, is the second Civil Engineer to be Dean. A graduate of the Army School of the Line, Langres, France in 1918, and of the G–1 course of the War College, Washington, D. C., in 1926, he brings to the college a wide experience in the field of engineering education. He has been a teacher of Civil Engineering since 1912, the Dean of the College of Engineering at the University of Idaho for fourteen years, and the Dean of the School of Engineering and Architecture at the University of Kansas for three years. He seems well fitted to carry forward the great work of his predecessors.

Even if the University were still confined to its original smug little campus of 40 acres, Ann Arbor would seem an especially favorable place for a convention of engineering educators at this particular time. Detroit, which has for some years been recognized as the world's greatest automobile manufacturing center, has under the threat of war become the most important area in this country for the production of munitions of war. As Detroit is only 35 miles from Ann Arbor, the Committee on Arrangements will make ample provision for inspection trips to its titanic industries and to some of its great research laboratories. Flint, fast becoming an industrial rival of Detroit, is only 57 miles away; Midland, with its Dow Chemical Works, one of the four largest chemical plants in this country only 112 miles. And for those who, after the convention closes, wish to extend still further their inspection of points of interest to engineers, the Soo Canal, which carries more tonnage each year than the Panama and Suez Canals combined, and the great mining industries of the Northern Peninsula are easily accessible by boat or automobile. The food factories at Battle Creek, the furniture factories at Grand Rapids and the oil refineries of the Central Michigan oil fields are all easily accessible from Ann Arbor, and all offer interesting examples of modern factory methods.

Ann Arbor in June is at its best. Embowered in trees, it looks off across the valley of the Huron, which encirles it, to beau-

AIRPLANE VIEW OF THE MICHIGAN UNION SHOWING THE INTERNATIONAL CENTER IN THE FOREGROUND

tiful wooded hills. More than a hundred and fifty lakes within our county alone and the little winding rivers give this region great charm. Michigan, with its great fresh water seas, its more than 5000 smaller inland lakes, its hills and forests, has become one of the favorite recreation areas of the country. From Ann Arbor, those who wish to see this region after the convention can within a few hours reach almost any point in the lower Peninsula by automobile over excellent roads; the West Coast, the Traverse Bay region, Charlevoix, the Little Traverse, the Mackinac County and the wild Lake Superior country. The lake trips from Detroit to Duluth, or through Georgian Bay, or through the "Straits" to Chicago, or from Detroit down Lake Erie, Ontario and the St. Lawrence, all provide a refreshing experience. The Michigan Tourist Association and the A. A. A. have been asked by our local committee on entertainment to have their representatives at the convention to help plan such post-convention outings.

To the members of the Society of Engineering Education, your many friends at the University of Michigan extend a hearty welcome to Ann Arbor. We are looking forward to your coming with great pleasure, and shall do all in our power to make your stay interesting and profitable.

AIRPLANE VIEW OF THE MICHIGAN UNION SHOWING THE INTERNATIONAL CENTER IN THE FOREGROUND

ENGINEERING ENROLLMENTS, 1940–41

158 institutions giving instruction in engineering were requested to furnish the following information. 155 had replied as of November 26, 1940.

Engineering Courses	Freshmen (1st year)	Sophomores (2nd year)	Juniors (3d year)	Seniors (4th year)	5th Year (of 5-yr. Curriculum)	Special Students	Evening Students	Others (Please name)	Totals
Aeronautical.....	1,150	1,009	750	528	71	27	186	2	3,723
Agricultural.....	271	189	212	187	4	1	——	——	864
Architectural.....	310	313	239	234	15	6	——	2	1,119
Ceramic.....	199	172	151	171	——	37	——	——	730
Chemical.....	4,002	4,309	3,528	2,784	222	59	1,245	28	16,177
Civil.....	2,499	2,794	2,575	2,226	124	55	837	42	11,152
Electrical.....	3,185	4,035	3,477	2,913	161	76	1,630	28	15,505
Industrial.....	320	692	632	590	62	9	132	5	2,442
Mechanical.....	7,185	7,370	6,007	4,532	286	121	2,704	404	28,609
Metallurgical.....	385	537	603	497	3	5	240	6	2,276
Mining.....	578	534	595	547	11	19	8	2	2,294
Unclassified.....	13,666	2,722	1,659	1,433	83	100	5,963	101	25,727
Totals, 1940–41*....	33,250	24,676	20,428	16,642	1,042	515	12,945‡	620	110,618
Totals, 1939–40†....	31,797	24,184	19,552	16,782	877	458	11,624	628	105,892

* 155 schools reporting.

† 146 schools reporting.

‡ 994 are distributed among classes and should be added to this for Cooper Union.

Enrollment of Undergraduate Engineering Students, 1940–41

Institutions	Freshmen (1st year)	Sophomores (2nd year)	Juniors (3d year)	Seniors (4th year)	5th Year (of 5-yr. Curriculum)	Special Students	Evening Students	Others	Totals 1939	Totals 1940	No. of First Degrees Conferred During the Academic Year 1939–40
Akron	103	57	47	28	40	3	—	—	161	278	27
Ala. Poly	423	385	247	216	1	6	—	—	1,058	1,278	151
Ala. Uni	328	192	129	131	50	—	103	—	894	933	106
Alaska	52	29	26	13	1	1	—	—	102	122	18
Arizona	119	105	94	58	—	7	—	—	418	383	45
Arkansas	97	85	85	64	—	1	—	—	355	332	36
Bradley P. I	68	33	5	3	—	—	—	—	—	109	—
Brooklyn P. I	166	169	137	87	—	23	1,290	—	1,926	1,872	111
Brown	65	41	42	23	—	—	—	—	159	171	25
Bucknell	113	69	45	34	—	—	—	—	226	261	35
Calif. Uni	370	334	633	531	—	8	—	—	2,016	1,876	302
Calif. So. Uni	69	82	102	88	—	9	406	—	590	756	66
Calif. I. T	160	87	126	101	48	—	—	—	466	542	131
Carnegie I. T	362	313	259	208	—	5	863	—	1,965	2,010	232
Case Sch. Ap. Sci	324	225	211	192	—	—	725	29	1,557	1,706	166
Catholic	103	59	55	45	—	6	—	—	188	268	36
Cincinnati	366	246	261	204	199	—	325	—	1,486	1,601	144
Citadel	65	75	49	24	—	—	—	—	210	213	26
Clarkson Coll	171	125	121	93	—	—	—	—	466	510	63
Clemson Coll	375	222	160	123	—	—	—	—	774	880	65
Colo. St. Coll	108	78	60	48	—	—	—	—	282	294	45

Enrollment of Undergraduate Engineering Students, 1940–41—Continued

Institutions	Freshmen (1st year)	Sophomores (2nd year)	Juniors (3d year)	Seniors (4th year)	5th Year (of 5-yr. Curriculum)	Special Students	Evening Students	Others	Totals 1939	Totals 1940	No. of First Degrees Conferred During the Academic Year 1939–40
Colo. Mines	207	224	185	157	—	—	—	—	750	773	147
Colo. Uni.	310	209	188	160	—	—	—	—	830	867	143
Columbia Coll.	129	—	—	—	—	—	—	—	272	129	—
Columbia Uni.	—	99	121	78	41	47	—	70	213	456	45
Conn. Uni.	128	52	36	14	—	—	—	—	138	230	6
Cooper U. (Day)	112	101	81	52	—	—	—	—	336	346	58
Cooper U. (Eve.)	243	185	209	137	126	94	—	—	961	994	60
Cornell	469	386	278	201	16	—	—	—	1,240	1,350	146
Dartmouth	—	—	—	15	8	—	—	—	18	23	—
Dayton	62	43	35	38	—	7	131	—	270	316	27
Delaware	81	62	42	37	—	4	—	—	230	226	32
Denver	71	39	22	20	—	—	—	—	95	152	21
Detroit	275	153	160	94	89	6	60	19	782	856	71
Drexel	332	221	125	96	106	—	—	—	3,558	880	102
Duke	77	52	52	44	—	9	—	—	214	234	26
Fenn Coll.	165	94	66	38	37	—	575	—	679	975	70
Florida	200	140	72	66	—	—	—	—	424	478	56
Ga. Sch. Tech.	728	649	481	330	5	5	—	—	1,897	2,198	275
Geo. Wash. Uni.	220	99	67	36	—	76	—	—	339	498	39
Gonzaga Uni.	71	45	22	14	—	—	—	—	—	152	2

Enrollment of Undergraduate Engineering Students, 1940–41—Continued

Institutions	Freshmen (1st year)	Sophomores (2nd year)	Juniors (3d year)	Seniors (4th year)	5th Year (of 5-yr. Curriculum)	Special Students	Evening Students	Others	Totals 1939	Totals 1940	No. of First Degrees Conferred During the Academic Year 1939–40
Harvard*	——	38	33	30	——	——	——	9	114	110	45
Hawaii	40	31	23	9	——	——	——	29	100	132	——
Howard	41	5	4	4	——	——	——	——	42	54	5
Idaho	166	101	86	56	——	——	——	——	394	409	67
Ill. Inst. Tech.	393	296	252	187	——	69	2,506	384	3,442	4,087	157
Illinois	848	501	476	465	——	——	——	——	2,349	2,290	387
Iowa St. Coll.	610	615	413	315	——	3	——	——	1,884	1,956	260
Iowa Uni.	171	117	96	96	——	——	——	——	432	480	68
Johns Hopkins	93	99	76	60	——	——	1,368	——	1,579	1,696	68
Kansas St. Coll.	376	258	226	186	——	1	——	——	1,013	1,047	153
Kansas Uni.	210	164	144	127	——	4	——	——	688	649	104
Kentucky	159	116	92	61	——	1	——	——	421	429	58
Lafayette Coll.	109	86	76	61	——	——	——	——	319	332	53
Lehigh	359	249	233	199	——	——	——	——	1,110	1,040	173
La. So. W. Inst.	110	67	34	25	——	——	——	——	244	236	——
La. St. Uni.	529	152	251	231	——	16	——	——	1,072	1,179	115
Louisville	99	83	50	48	——	——	44	——	283	324	33
Maine	200	155	143	105	——	8	——	——	610	611	59
Manhattan Coll.	100	82	68	57	——	——	——	——	283	307	47

* Eng. Science in Harvard College.

Enrollment of Undergraduate Engineering Students, 1940–41—Continued

Institutions	Freshmen (1st year)	Sophomores (2nd year)	Juniors (3d year)	Seniors (4th year)	5th Year (of 5-yr. Curriculum)	Special Students	Evening Students	Others	Totals 1939	Totals 1940	No. of First Degrees Conferred During the Academic Year 1939–40
Marquette	178	153	98	96	81	7	—	—	572	613	—
Maryland	227	218	92	50	3	—	—	7	541	597	56
Mass. I. T.	605	487	489	463	6	—	—	—	1,957	2,050	409
Mich. M. & T.	192	216	203	160	1	—	—	—	792	772	127
Mich. St. Coll.	323	292	191	152	—	—	—	—	933	958	125
Mich. Uni.	505	543	567	426	—	11	—	—	2,151	2,052	410
Minnesota	586	543	524	420	18	—	—	—	2,112	2,091	348
Miss. St. Coll.	246	164	129	100	—	—	—	—	712	639	126
Miss. Uni.	21	22	15	13	—	—	—	—	—	71	—
Missouri Mines	264	207	220	179	—	—	—	—	808	870	156
Missouri Uni.	233	148	146	95	—	—	—	—	596	622	65
Mont. St. Coll.	188	140	74	73	—	—	—	—	480	475	75
Mont. Mines	86	88	62	54	—	—	—	—	298	290	—
Nebraska	326	204	131	117	3	—	—	—	746	781	84
Nevada	63	61	57	40	—	—	—	—	—	221	—
Newark Coll.	191	174	109	87	—	—	144	—	916	705	148
New Hampshire	130	119	74	64	—	3	—	—	394	390	58
New Mexico	111	72	38	30	—	—	—	—	226	251	19
New Mex. A. M.	71	32	39	40	—	—	—	—	201	182	19
New Mex. Mines	38	39	34	28	—	2	—	—	158	141	—
N. Y. Ceramics	73	57	45	53	—	—	—	—	220	228	39
N. Y. City Coll.	772	412	309	265	—	—	1,494*	26	1,413	3,278	209

* Not included in 1939 enrollment.

Enrollment of Undergraduate Engineering Students, 1940–41—Continued

Enrollment of Undergraduate Engineering Students, 1940–41—Continued

Institutions	Freshmen (1st year)	Sophomores (2nd year)	Juniors (3d year)	Seniors (4th year)	5th Year (of 5-yr. Curriculum)	Special Students	Evening Students	Others	Totals 1939	Totals 1940	No. of First Degrees Conferred During the Academic Year 1939–40
New York Uni....	289	302	217	184	—	—	1,157	44	2,069	2,193	240
No. Car. St. Coll...	612	308	203	199	—	—	—	—	1,185	1,322	141
No. Dak. St. Coll..	161	62	52	51	—	—	—	—	313	326	—
No. Dak. Uni.....	89	66	44	36	2	35	—	—	126	272	34
Northeastern.....	403	351	298	231	200	—	—	—	1,424	1,483	135
Northwestern.....	190	106	49	47	—	6	—	—	269	398	39
Norwich.....	103	57	41	27	—	—	—	—	141	228	—
Notre Dame.....	192	169	77	84	3	4	—	—	495	529	62
Ohio St. Uni.....	560	557	344	328	11	—	—	—	1,776	1,800	262
Ohio Uni.....	140	40	35	27	—	—	—	—	156	242	—
Ohio No. Uni.....	54	36	41	25	—	1	—	—	150	157	—
Okla. A. M.....	488	279	256	191	—	6	—	—	1,246	1,220	142
Okla. Uni.....	472	326	385	368	—	—	—	—	1,592	1,551	—
Ore. St. Coll.....	376	252	202	131	—	—	—	—	860	961	119
Pa. St. Coll.....	590	470	362	292	—	4	—	—	1,614	1,718	293
Pa.: Towne Sci....	108	93	80	64	—	—	—	—	343	345	57
Moore Sch. E. E.	21	22	22	24	—	—	—	—	84	89	14
Pittsburgh.....	293	245	222	202	—	15	308	—	1,134	1,285	173
Porto Rico.....	90	84	73	66	—	—	—	—	763	313	43
Pratt Inst.....	203	141	128	86	—	—	—	—	—	558	81
Princeton.....	128	118	83	60	15	—	—	—	379	404	56
Purdue.....	1,076	1,003	807	595	—	6	—	—	3,681	3,487	522
Rensselaer.....	398	283	297	278	—	4	—	—	1,203	1,260	198

Enrollment of Undergraduate Engineering Students, 1940–41—Continued

Institutions	Freshmen (1st year)	Sophomores (2nd year)	Juniors (3d year)	Seniors (4th year)	5th Year (of 5-yr. Curriculum)	Special Students	Evening Students	Others	Totals 1939	Totals 1940	No. of First Degrees Conferred During the Academic Year 1939–40
R. I. St. Coll.	109	79	79	54	—	—	—	—	325	321	49
Rice Inst.	185	146	104	98	1	—	—	—	490	534	55
Rochester	67	42	29	34	—	—	—	—	148	172	16
Rose Poly. Inst.	98	87	56	42	—	—	—	—	260	283	34
Rutgers	99	57	48	40	—	6	—	—	233	250	—
Santa Clara	32	22	20	8	—	—	—	—	94	82	9
So. Car. Uni.	81	64	29	30	—	—	—	—	—	204	14
So. Dak. Coll.	121	30	45	34	—	—	—	—	—	230	—
So. Dak. Mines	114	91	63	43	—	—	—	—	356	311	73
So. Meth. Uni.	76	45	33	25	17	—	—	—	166	196	15
Stanford	110*	100*	94	113	—	—	—	—	367	417	74
Stevens I. T.	204	171	119	124	—	2	—	—	603	620	91
Swarthmore C.	28	22	12	11	—	—	—	—	70	73	14
Syracuse	168	106	76	84	—	4	—	—	442	438	67
Tenn. Poly.	88	49	29	12	—	—	—	—	—	178	—
Tenn. Uni.	248	271	128	91	—	—	—	—	685	738	64
Texas A. M.	1,265	746	648	426	13	3	—	—	2,823	3,101	241
Texas Uni.	380	425	386	285	—	—	—	—	1,497	1,476	—
Texas Tech.	217	194	182	146	—	—	—	—	809	739	62
Texas A. & I.	78	51	35	33	—	—	—	—	225	197	18
Toledo	153	89	59	50	—	2	227	4	494	584	29
Tufts Coll.	131	96	82	85	—	—	—	—	387	394	77
Tulane	168	95	57	49	—	2	—	—	346	371	36
Tulsa	81	51	36	26	20	—	—	—	—	214	26

* Approximate.

Enrollment of Undergraduate Engineering Students, 1940–41—Continued

* Approximate.

Enrollment of Undergraduate Engineering Students, 1940–41—Continued

Institutions	Freshmen (1st year)	Sophomores (2nd year)	Juniors (3d year)	Seniors (4th year)	5th Year (of 5-yr. Curriculum)	Special Students	Evening Students	Others	Totals 1939	Totals 1940	No. of First Degrees Conferred During the Academic Year 1939–40
Union Coll.	61	36	37	30	—	—	—	—	166	164	23
U. S. Coast Guard	131	76	32	22	—	—	—	—	—	261	—
Utah Ag. Coll.	67	60	46	39	—	—	—	—	173	212	—
Utah Uni.	156	182	108	69	—	—	—	—	485	515	—
Valparaiso	25	15	—	—	—	—	—	—	53	40	—
Vanderbilt	87	57	50	38	—	—	—	—	220	232	—
Vermont	43	40	27	23	—	—	—	—	136	133	19
Villanova Coll.	95	70	39	38	—	—	—	—	232	242	38
Va. Mil. Inst.	120	106	87	68	—	—	—	—	343	381	79
Va. Poly. Inst.	679	454	292	265	—	5	—	—	1,624	1,695	248
Va. Uni.	90	81	40	38	—	—	—	—	238	249	26
Wash. U. (St. Louis)	133	94	92	50	—	8	—	—	391	377	—
Wash. Uni.	689	206	273	276	—	—	—	—	1,394	1,444	176
Wash. St. Coll.	215	149	126	139	—	—	—	—	651	629	80
Wayne	147	111	73	54	—	1	269	—	667	655	—
Webb Inst.	19	14	17	13	—	—	—	—	65	63	13
W. Va. Uni.	163	146	116	83	—	—	—	—	537	508	87
Wisconsin	490	362	345	275	—	—	—	—	1,447	1,472	199
Worcester P. I.	204	153	145	103	—	—	—	—	606	605	—
Wyoming	125	103	67	62	—	2	—	—	354	359	38
Yale	—	80	103	56	—	—	—	—	255	239	74

Enrollment of Undergraduate Engineering Students, 1940–41—Continued

Institutions	Freshmen (1st year)	Sophomores (2nd year)	Juniors (3d year)	Seniors (4th year)	5th Year (of 5-yr. Curriculum)	Special Students	Evening Students	Others	Totals 1939	Totals 1940	No. of First Degrees Conferred During the Academic Year 1939–40
U. S. Schools Totals.....	33,175	24,242	20,120	16,310	985	514	12,945	620	102,879	110,911	11,358
Canadian Schools											
Alberta Uni.....	126	82	48	43	—	—	—	—	—	299	—
Ecole Poly.....	106	69	40	45	33	—	—	—	291	293	30
McGill Uni.....	—	—	—	—	—	—	—	—	460	—	—
New Brunswick...	—	—	—	—	—	—	—	—	179	—	—
Queen's Uni.....	168	163	124	132	—	1	—	—	633	588	136
Nova Scotia Tech..	—	—	—	33	24	—	—	—	—	57	—
Saskatchewan.....	175	120	96	79	—	—	—	—	492	470	—
Toronto.....	—	—	—	—	—	—	—	—	958	—	—
Canadian.....	575	434	308	332	57	1	—	—	3,013	1,707	166
United States.....	33,175	24,242	20,120	16,310	985	514	12,945	—	102,879	108,911	11,358
Totals.....	33,750	24,676	20,428	16,642	1,042	515	12,945	620	105,892	110,618	12,524

Graduate Engineering Enrollment, 1940–41

Engineering Courses	Enrollment in Work for the Master's Degree						Enrollment in Work for the Doctor's Degree					
	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others	Total	Masters Degrees Conferred in 1939–40	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others	Total	Doctors Degrees Conferred in 1939–40
Aeronautical	79	51	—	—	130	47	15	6	—	3	24	5
Agricultural	8	19	—	1	28	25	—	3	—	1	3	—
Architectural	14	7	—	—	21	7	1	—	—	—	1	—
Ceramic	10	4	—	—	14	17	14	6	—	—	20	3
Chemical	381	141	357	31	910	321	161	60	13	3	237	38
Civil	277	102	220	4	603	300	41	14	7	4	66	9
Electrical	326	266	390	2	984	214	66	32	18	4	120	20
Industrial	31	34	113	—	178	15	—	—	2	—	2	—
Mechanical	382	140	358	15	895	170	39	9	—	—	48	7
Metallurgical	95	58	63	—	216	59	42	6	1	—	49	8
Mining	44	19	—	—	63	29	1	6	—	—	7	2
Unclassified	360	98	98	—	556	124	24	19	—	3	46	13
Totals	2,007	939	1,599	53	4,598	1,329	404	161	41	18	623	108

Graduate Engineering Enrollment, 1940–41—Continued

Institutions	Enrollment in Work for the Master's Degree						Enrollment in Work for the Doctor's Degree					
	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others	Total	Masters Degrees Conferred in 1939–40	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others	Total	Doctors Degrees Conferred in 1939–40
Ala. Poly	5	—	—	—	5	4	—	—	—	—	—	—
Ala. Uni	5	1	—	—	6	4	—	—	—	—	—	—
Arizona	6	2	—	—	8	3	—	—	—	—	—	—
Arkansas	—	2	—	—	2	0	—	—	—	—	—	—
Brooklyn	—	9	261	—	270	26	—	3	20	—	23	—
Brown	—	—	—	—	—	1	—	—	—	—	—	—
Calif. I. T.	103	—	—	—	103	57	19	—	—	7	26	10
Calif. Uni.	113	—	—	—	113	37	—	—	—	—	—	2
Calif. So. Uni.	2	23	—	—	25	10	—	—	—	—	—	—
Carnegie	21	—	92	—	113	15	9	—	—	—	9	2
Case	5	35	45	—	85	28	—	6	2	—	8	1
Catholic	1	9	—	—	10	5	—	—	—	—	—	—
Cincinnati	12	11	—	—	23	11	8	—	—	—	8	6
Colo. Mines	14	—	—	—	14	7	—	—	—	—	—	—
Colo. Uni.	56	—	—	—	56	14	—	—	—	—	—	—
Conn. Uni.	—	38	—	—	38	0	—	—	—	—	—	—
Cornell	23	—	—	—	23	39	19	—	—	—	19	3
Delaware	1	3	—	—	34	38	1	—	—	—	—	—
Florida	6	—	—	—	6	0	—	—	—	—	—	—
Ga. Sch. Tech.	—	26	—	—	26	16	—	—	—	—	—	—

Graduate Engineering Enrollment, 1940–41—Continued

Ga. Sch. Tech.	—	26	—	—	26	16	—	—	—	—	—	—

Graduate Engineering Enrollment, 1940–41—Continued

Institutions	Enrollment in Work for the Master's Degree						Enrollment in Work for the Doctor's Degree					
	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others	Total	Masters Degrees Conferred in 1939–40	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others	Total	Doctors Degrees Conferred in 1939–40
Harvard	93	15	—	—	108	97	14	17	—	1	32	8
Idaho	5	—	—	—	5	9	—	—	—	—	—	—
Ill. Inst. Tech.	34	—	294	—	328	24	13	—	—	—	13	0
Illinois Uni.	8	41	—	—	49	27	7	24	—	—	31	6
Iowa St. Coll.	3	39	—	—	42	27	3	15	—	—	18	0
Iowa Uni.	18	13	—	—	31	24	10	4	—	—	14	3
Johns Hopkins	4	18	—	—	22	2	19	7	—	3	29	4
Kansas St. Coll.	4	15	—	14	33	9	—	—	—	—	—	—
Kansas Uni.	1	5	—	—	6	4	—	—	—	—	—	—
Kentucky	2	—	—	—	2	1	—	—	—	—	—	—
Lafayette	2	—	—	—	2	3	—	—	—	—	—	—
Lehigh	9	42	—	—	51	35	2	17	—	—	19	0
Louisville	6	—	24	—	30	11	—	—	—	—	—	—
La. So. W. Inst.	236	—	—	—	236	0	—	—	—	—	—	—
Louisiana Uni.	11	4	3	—	18	10	1	—	—	—	1	0
Maine	2	10	—	—	12	2	—	—	—	—	—	—
Maryland	—	4	—	—	4	0	4	—	—	—	4	1
Mass. Inst. Tech.	333	—	—	—	333	227	122	—	—	—	122	21
Mich. Mines	5	—	—	—	5	3	—	—	—	—	—	—
Mich. Uni.	144	—	—	—	144	117	54	—	—	—	54	7

Graduate Engineering Enrollment, 1940–41—Continued

Institutions	Enrollment in Work for the Master's Degree						Enrollment in Work for the Doctor's Degree					
	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others	Total	Masters Degrees Conferred in 1939–40	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others	Total	Doctors Degrees Conferred in 1939–40
Mich. St. Coll.	—	19	—	—	19	4	—	—	—	—	—	—
Minnesota	94	—	—	—	94	31	7	—	—	—	7	7
Mo. Mines	16	—	—	—	16	4	2	—	—	—	2	0
Mo. Uni.	15	10	—	—	25	5	—	—	—	—	—	—
Mont. Mines	16	—	—	—	16	10	—	—	—	—	—	—
Mont. St. Coll.	2	—	—	—	2	1	—	—	—	—	—	—
Nebraska	6	—	—	—	6	2	—	—	—	1	1	1
Newark Coll.	—	—	104	—	104	0	—	—	—	—	—	—
New Hampshire	—	4	—	—	4	5	—	—	—	—	—	—
N. Y. Coll. Ceramics	1	—	—	—	1	0	—	—	—	—	—	—
New York Uni.	61	32	255	—	348	34	1	6	16	—	23	0
No. Car. St. Coll.	23	—	—	—	23	12	—	—	—	—	—	—
Northwestern	1	1	28	—	30	2	—	—	—	—	—	—
No. Dak. Uni.	1	—	—	—	1	5	—	—	—	—	—	—
Notre Dame	5	—	—	—	5	0	—	—	—	—	—	—
Ohio State	21	15	—	4	40	27	16	7	—	2	25	7
Oklahoma Uni.	—	—	—	—	—	—	—	—	—	—	—	—
Okla. A. M.	8	7	—	—	15	17	—	—	—	—	—	—
Oregon	12	—	—	—	12	1	—	—	—	—	—	—
Pa. St. Coll.	9	35	—	—	44	27	3	19	—	—	22	2
Pa.: Towne Sci.	1	10	89	—	100	6	1	4	—	—	5	0
Moore Sch. E. E.	5	—	79	—	84	2	—	10	3	—	13	0

Graduate Engineering Enrollment, 1940–41—Continued

Graduate Engineering Enrollment, 1940–41—Continued

Institutions	Enrollment in Work for the Master's Degree						Enrollment in Work for the Doctor's Degree					
	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others	Total	Masters Degrees Conferred in 1939–40	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others	Total	Doctors Degrees Conferred in 1939–40
Pittsburgh	—	297	—	—	297	12	—	—	—	—	—	4
Princeton	15	—	—	—	15	14	—	—	—	—	—	—
Purdue	68	—	—	—	68	27	30	—	—	—	30	2
Rensselaer	16	9	—	—	25	20	—	—	—	—	—	—
R. I. St. Coll.	—	1	—	—	1	0	—	—	—	—	—	—
Rice Inst.	2	—	—	—	2	0	1	—	—	—	1	0
Rochester	4	2	—	—	6	3	—	—	—	—	—	—
Rutgers	8	—	—	—	8	3	—	—	—	—	—	—
So. Dak. Mines	—	3	—	—	3	2	—	—	—	—	—	—
So. Dak. St. Coll.	—	3	—	—	3	0	—	—	—	—	—	—
Stanford	96	—	—	—	96	28	—	—	—	—	—	—
Stevens	1	11	325	—	337	5	—	—	—	—	—	—
Tennessee	41	—	—	—	41	11	—	—	—	—	—	—
Texas A. M.	29	—	—	—	29	8	—	—	—	4	4	0
Texas Tech.	2	—	—	—	2	3	—	—	—	—	—	—
Texas Uni.	26	22	—	—	48	0	—	6	11	—	17	5
Tulane	1	8	—	—	9	3	—	—	—	—	—	—
Tulsa	1	4	—	—	5	0	—	—	—	—	—	—
Union	—	1	—	—	1	0	—	—	—	—	—	—
Utah Ag. Coll.	2	—	—	—	2	0	—	—	—	—	—	—
Utah Uni.	5	—	—	—	5	4	—	—	—	—	—	—

Graduate Engineering Enrollment, 1940–41—Continued

Institutions	Enrollment in Work for the Master's Degree						Enrollment in Work for the Doctor's Degree					
	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others	Total	Masters Degrees Conferred in 1939–40	Full-Time Resident Students	Part-Time Resident Students	Evening Students	Others	Total	Doctors Degrees Conferred in 1939–40
Vermont	1	—	—	—	1	0	—	—	—	—	—	—
Va. Poly. Inst.	40	11	—	—	51	33	—	2	—	—	2	0
Va. Uni.	2	—	—	—	2	3	—	—	—	—	—	—
Wash. St. Coll.	3	—	—	—	3	0	—	—	—	—	—	—
Wash., Uni. of	17	5	—	—	22	14	—	—	—	—	—	—
West Virginia	4	7	—	—	11	8	—	—	—	—	—	—
Wisconsin	—	32	—	—	32	16	—	9	—	—	9	7
Worcester P. I.	2	13	—	—	15	4	—	—	—	—	—	—
Wyoming	—	—	—	1	1	0	—	—	—	—	—	—
Yale	27	—	—	—	27	16	33	—	—	—	33	8
U. S. Schools Totals	2,003	927	1,599	53	4,582	1,318	404	161	41	18	623	108
Canadian Schools												
Ecole Poly.	—	1	—	—	1	0	—	—	—	—	—	—
Queen's Uni.	4	7	—	—	11	6	—	—	—	—	—	—
Saskatchewan	—	4	—	—	4	2	—	—	—	—	—	—
Totals	2,006	931	1,599	53	4,589	1,326	404	161	41	18	623	108

REPORT OF CONFERENCES

The conferences of the **Chemical Engineering Division** consisted of four regular sessions and a luncheon meeting for transacting the business of the division. The subjects of discussion in the regular conferences were as follows:

Monday Morning: Training of Chemical Engineers for Industry, W. M. Cobleigh (Montana State) presiding.

Monday Afternoon: Laboratory Courses in Chemical Engineering, Division Chairman Joseph H. Koffolt (Ohio State) presiding.

Tuesday Afternoon: Lecture Recitation Courses in Chemical Engineering, P. M. Horton (Louisiana State) presiding.

Thursday Afternoon: Methods of Teaching Chemical Engineering, R. C. Kintner (Armour) presiding.

One of the highlights of the meeting was the annual dinner at which the ladies were guests. The speaker on this occasion was Dean Joel H. Hildebrand (California) who discussed the subject of "Chemical Warfare" in the light of his many years of experience as Colonel in the United States Chemical Warfare Service.

Although the attendance was somewhat less than that of the preceding meeting, which included the added attraction of the subsequent Summer School for Chemical Engineering Teachers, there was an average attendance of 30 delegates at the regular sessions. Total registrations numbered 41, representing 33 institutions.

Papers and Discussion

The Division was extended a hearty welcome to the University of California by Professor Merle Randall, Chairman of the local committee, who also invited the delegates to visit the laboratories of Chemistry and Chemical Engineering. Division Chairman J. H. Koffolt (Ohio State) expressed the appreciation of the division in his response.

Monday Morning: Training of Chemical Engineers for Industry:

P. D. Manning (Chem. and Met. Editorial Representative), Industrial Opportunities of the Pacific Coast and the Pacific Northwest.

A. H. Hooker, Jr. (Hooker, Tacoma, Wash.), A Chemical Engineer in Industry.

H. K. Benson (U. of Wash.), Training the Chemical Engineer for Industry.

C. S. Grove (Minnesota), Graduate Placement—A Departmental Obligation.

In the absence of Dr. Manning, his paper was presented to the conference by P. M. Horton (Louisiana State). It was pointed out that in most cases, "industrial opportunity" is merely a state of mind in which some person is able to visualize new products or new uses for old products. Included in the paper was a chart showing the distribution and development of mineral resources in 11 western states. G. W. Gleeson (Oregon State) pointed out that recently millions of tons of low grade sodium nitrate had been discovered in this area, and that titanium has also been found in the beach sands of the Coast.

After outlining the important features of a good chemical engineering curriculum A. H. Hooker, Jr., presented some of his ideas regarding the chemical engineer in sales work, a field which is growing in importance to the profession.

In a discussion of the third paper Keyes (Illinois) pointed out the need for men capable of developing new products and processes. The young engineer should be capable of making accurate economic appraisals and of developing satisfactory economic balances. Courses should be modified to emphasize this point of view.

C. S. Grove presented the question of graduate placement both from the standpoint of the employer and the employee. An outline was presented for setting up a departmental placement office.

In the general discussion Randall suggested that the humanities be given in the senior year where a full appreciation of them would be gained. Classroom discussion in current affairs was also recommended for engineers. Regarding the placement of graduates, it was observed that the personnel representative was seeking a type of man for his individual plant, overlooking many good men who did reach physical standardization or some other arbitrary standard. A. H. White (Michigan), P. M. Horton, R. E. Vivian (Southern Cal.) and R. C. Kintner (Armour) also contributed to the discussion.

Monday Afternoon: Laboratory Courses in Chemical Engineering:

L. M. K. Boelter (California), Applications of Unit Operations Principles to Mechanical and Agricultural Engineering Laboratory Instruction.

W. L. Beuschlein (U. of Wash.), Unit Operations Laboratory Instruction. J. W. Greene (Kansas State), Safety.

H. McCormack (Armour), Applications of Chemical Engineering.

L. M. K. Boelter offered a number of new experiments which might be carried out in the laboratory to demonstrate the principles of heat transfer. It was also pointed out how other fields of engineering might well be adapted to the "unit operation" method of teaching.

In a formal discussion of the second paper, C. O. Miller (Case) suggested that the unit operations be presented as part of a related sequence rather than as isolated units, and advised that the student be permitted to use originality in the preparation of reports as long as they adhered to good engineering practice. Slides were shown of laboratory installations at Case.

J. W. Greene (Kansas State) emphasized the need of coöperation with the National Safety Council and of formulating a safety program in the laboratory.

A general discussion followed regarding the feasibility of using the unit operations technique in fields other than chemical engineering, Olsen (Brooklyn Poly.) and Boelter leading the discussion. W. L. Beuschlein expressed the opinion that too many hours were being spent in the laboratory and in writing reports for the credit given, and also recommended that data in the laboratory be taken over a wide variation of operating conditions so that small errors in readings would be minimized.

The conference expressed a hearty approval of a safety training program for colleges, an item which also headed the discussions of the chemical engineers at a recent Middle Atlantic Section Meeting in May 1940.

Tuesday Afternoon: Lecture Recitation Courses in Chemical Engineering:

B. Longtin (Armour) Minimum Requirements of Physical Chemistry for Chemical Engineers.

W. N. Lacey (Cal. Tech.) Chemical Engineering Thermodynamics for the Petroleum Industry.

C. W. Borgman (Colorado) Metallurgy for Chemical Engineers.

G. W. Gleeson (Oregon State) Implications of Undergraduate Training in Chemical Engineering.

Discussing the subject of physical chemistry for the chemical engineer, J. Elgin (Princeton) observed that it is becoming the duty of the chemical engineer to teach basic principles of equilibria, kinetics, diffusion, etc., to undergraduates or to give the student a utilizable knowledge of modernized classical physical chemistry, allowing pure scientists to explore the realms of quantum mechanics, atomic and molecular structure, theories of solutions, and statistics.

R. E. Vivian presented a formal discussion of the subject of metallurgy for the chemical engineers in which the field was classified into extractive and adaptive metallurgy, the former involving many of the unit operations as we know them, referred to as chemical metallurgy. Adaptive metallurgy, on the other hand, is physical metallurgy and it is doubtful if the chemical engineer should go into this field except perhaps for a course in metallography.

In the general discussion which followed Randall urged that the pure scientists be permitted to teach the physical chemistry. A. H. White pointed out the need for repetition in physical chemistry courses in order to assimilate thoroughly the subject matter. R. C. Kintner advocated the same drawing for chemical engineers as for mechanical engineers and the same chemistry as that given to chemistry majors. W. N. Lacey (Cal. Tech.) was not in favor of eliminating shop work from the curriculum and explained how summer work in this field could be given.

Discussing the subject of post graduate education, J. H. Koffolt (Ohio State) and M. Randall recited cases where executives and other employees of certain manufacturing concerns were periodically given instruction in the more recent developments in science and engineering through coöperation with the university.

Thursday Afternoon: Methods of Teaching Chemical Engineering:

R. C. Kintner (Armour), Teaching of Chemical Engineering.

M. Randall (California), Approach to Chemical Engineering Teaching at the University of California.

A. H. Cooper (Va. Poly.), Plant Studies—Inspection Trips.

E. E. Randolph (North Carolina State), Trends in Chemical Engineering Education.

L. B. Shires (New Mexico State), Correlation of Subject Matter of Courses in the Chemical Engineering Curriculum by means of Comprehensive Problems and Senior Projects.

W. M. Cobleigh (Montana State), Five Year Curriculum in Chemical Engineering.

Comments on the first paper were made by C. L. Nickolls (Okla A. and M.), L. B. Shires (New Mexico State) and W. M. Cobleigh (Montana State) in which each expressed his appreciation of the advantages of the Summer School for Teachers of Chemical Engineering, held at Pennsylvania State College.

Questions regarding the scope and cost of inspection trips were discussed by A. H. Cooper (Virginia Poly.), R. C. Kintner and C. L. Nickolls with general agreement that the trips were profitable and should be taken not earlier than the end of the junior year. L. C.

Cady (U. of Idaho) recommended seminar sessions for the purpose of discussing plants and processes before visitation. The practice of appointing each student to be an "expert" on a certain plant for the purpose of helping the guide has proved to be effective.

With regard to the five year curriculum, James R. Withrow (Ohio State) pointed out its desirability from the teachers' standpoint and discussed the various lines along which revision of the curriculum could be made. It was however generally agreed that the four year program was desirable for most institutions at the present time. A plea was made for better instruction in science and mathematics in our secondary schools and also for permitting the exceptional student to pursue advanced work while in college.

Business of the Division

The business meeting was held immediately following the luncheon on Thursday, June 27th, Chairman Joseph H. Koffolt presiding. The reading of the minutes was omitted inasmuch as a secretarial report of the Pennsylvania State Meeting had been published in the Journal of Engineering Education, *30*, 106, 1939. The treasurer reported that the Summer School had provided a substantial increase to the treasury, and that the division was in good financial condition. Without incurring unforeseen expenses, it was recommended that there be no dues assessment on members during the year 1940–41. This recommendation was unanimously adopted.

The Laboratory Committee, H. McCormack (Armour) chairman, reported that with the publication of the new text book on "Applications of Chemical Engineering," the work of the committee is completed, but strongly recommended continuation with new members to supervise revision and extension of the book. This recommendation was unanimously adopted.

The committee on "Unit Processes," R. N. Shreve (Purdue) chairman, reported conducting two symposia on unit processes. It was moved (Beuschlein) that the committee be continued with additional members appointed. The motion was unanimously passed.

After hearing the report of the committee on the "Chemical Engineering Page," R. M. Boarts (Tennessee) chairman, it was moved (White) that the report be accepted and that the committee be tabled for the present. Motion unanimously adopted.

The program topic committee, F. C. Vilbrant (Virginia Poly.) chairman, presented a number of topics for consideration which were turned over to the new committee for their consideration. White proposed the topic of "The Chemical Engineer in National

Defense." Kintner suggested that a photographic exhibit of equipment be compiled for the next meeting. Olsen suggested that drawings accompany the photographs.

M. C. Molstad (Penn.), chairman of the committee on "Joint Conferences," proposed that at least one joint conference be held the coming year. White moved that the new committee be instructed to form a joint committee with some other division (which they shall invite) to outline a program for a joint meeting with contributions from both divisions. This motion was approved.

In the report of the Local Sections Committee, G. W. Gleeson (Oregon State) chairman, there were six specific recommendations made for coördinating the activities of the local sections. Most of the suggestions met with the approval of the conference and will be carried out during the coming year. These recommendations may be found in the committee report appended to these minutes.

New Business: J. W. Greene (Kansas State) recommended that the division coöperate with the National Safety Council in its program by

a. The organization of subject matter for safety.
b. Making recommendations to the Council in the form of new ideas for safety.

The chairman appointed Mr. Greene to act as the division's representative in this work.

As chairman of the resolutions committee A. H. White offered the following resolution: "Resolved that the Chemical Engineering Division of the Society for the Promotion of Engineering Education vote its thanks to the local committee for the courtesies extended and commend them for the skillful handling of the Division's activities.

"Be it further resolved that the Division express its appreciation to the retiring officers for their thorough and efficient work during the past year and to those who have contributed to the success of the meeting by the presentation of papers and discussions."

The nominating committee, R. C. Kintner (Armour) chairman, submitted the following for officers for 1940–41. They were unanimously elected.

Chairman—J. H. Rushton (U. of Virginia),
Vice-chairmen—W. L. Faith (Kansas State); J. C. Whitwell (Princeton),
Secretary-Treasurer—C. O. Miller (Case School of Applied Science).

C. O. MILLER,
Acting Secretary

The program of the **Civil Engineering Division** consisted of general sessions, committee conferences and sub-committee reports, joint divisional conferences, young men's forum, luncheon meetings and the annual dinner. The meetings were arranged by the chairmen of the separate groups as follows: *Committee I*—Harmer E. Davis (Univ. of Cal.), Informal meeting, Educational Policy and Teaching Methods; *Committee II*—E. H. Gaylord (The Ohio Univ.), Structural Engineering; *Committee III*—Edward R. Stapley (Okla. A. & M. Col.), Sanitary Engineering; *Committee IV*—E. T. Howson (Editor, Railway Age, Chicago), Transportation; *Committee V*—W. M. Lansford (Univ. of Ill.), Applied Hydraulics; *Committee VI*—C. A. Mockmore (Oregon State Col.), Construction Education; *Committee VII*—P. C. Rutledge (Purdue Univ.) and Frederick J. Converse (Cal. Inst. of Tech.), Soil Mechanics and Foundations; *Committee VIII*—Douglas S. Trowbridge (New York Univ.), Surveying and Geodesy; L. O. Stewart (Iowa State Col.), Young Men's Forum; Eugene L. Grant (Stanford Univ.), Engineering Economy; A. S. Adams (Col. Sc. of Mines), E. H. Gaylord, F. T. Mavis (Penn. State Col.) and H. D. Eberhart (Univ. of Cal.), Photoelasticity; Dean Charles Derleth, Jr. and Raymond E. Davis (Univ. of Cal.), Annual Dinner; and M. W. Furr (Kan. State Col.), General Chairman. The Division's program was broad in scope including more than forty papers and discussions on the teaching of civil engineering subjects as well as the technical and professional aspects of civil engineering. The 1939–1940 roster of standing committees was published in the *Civil Engineering Bulletin*, Vol. IV, No. 1, December 1939, pages 10–11.

Sub-Committee Investigations and Reports.—Extensive studies were made and a preliminary report was submitted by M. I. Evinger (Univ. of Nebr.), Chairman, R. W. Abbett (Union Col.), J. W. Howard (Univ. of Idaho) and G. E. Tomlinson (T. V. A.), on a Survey of Employment of Engineers in Construction Industries. This report was read by C. A. Mockmore (O. S. C.), Chairman of the Committee on *Construction Education*. Also, a report on a Survey of Employment of Engineers in Construction Industries was presented by R. H. Sherlock (Univ. of Mich.), Chairman; A. L. Chambers (Univ. of Ky.) and L. D. Conkling (Mont. State Col.). *Applied Hydraulics*—Report (D–1a) on the Survey of a Single First Course In Fluid Mechanics For All Engineering Students, by sub-committeemen C. L. Barker (Wash. State), Chairman, and R. A. Dodge (Univ. of Mich.). Professor Dodge's discussion consisted of a paper entitled An Unorthodox Laboratory Course To Accompany Elementary Fluid Mechanics. An interesting report (D–2) and recommendations of the sub-committee on Coöperation

with National Societies was prepared and presented by J. G. Woodburn (Univ. of Wis.), Chairman; E. W. Lane (S. U. I.) and C. H. Wright (Brooklyn Poly.). *Sanitary Engineering*—The report on Short Schools for Water and Sewage Works Operators was submitted by Wm. E. Stanley (Cornell Univ.) Chairman, and Ernest Boyce (Univ. of Kansas).

The third annual *Young Men's Forum* was conducted by L. O. Stewart, Head of the Department of Civil Engineering of Iowa State College. Papers were presented by H. Loren Thompson (Univ. of Idaho), Hugh G. Conley (U. S. C.) and R. E. Ayre Oregon State Col.). Mr. Thompson's discussion of the Changing Field of Employment and Possible Implications for Curriculum Adjustment was received with much interest. The topics covered by Messrs. Conley and Ayre were: The Value and Need of Organized Employee Training Programs in Civil Engineering and The Usefulness of Research and Graduate Work, respectively. These papers also were interesting and valuable discourses. The Society enjoys and appreciates the assistance of young instructors in the forum programs. The speakers and Professor Stewart are to be congratulated.

Much credit is due Eugene L. Grant, Chairman, Committee of Engineering Economy for his efforts to effect a program on *Engineering Economy* in coöperation with the Committee on Construction Education of the Civil Engineering Division. The topics of Economy Studies for Public Works and Teaching Public Works Economy were presented, respectively, by Edward Hyatt (State Engineer, Cal.), and Thomas C. Adams (Univ. of Utah). S. B. Morris (Stanford Univ.) discussed some of the phases of the subjects of the program.

A program on *Photoelasticity* was sponsored by a triangular chain of interests represented by the Mechanics Division, the Committee on Engineering Research, and the Structural Engineering Committee of the Civil Engineering Division. The program was worked out jointly by Professors Adams, Gaylord, Eberhart and Mavis. H. D. Eberhart (Univ. of Cal.) presided at the conference. The following brief report is from the notes of G. M. Duke (Univ. of Cal.), recorder. Attendance 60. In the absence of M. M. Frocht (Carnegie Tech.), B. F. Ruffner (Oregon State Col.), and R. G. Minarik (Kimberly-Clark Corp., Wis.), their papers and discussions were read by Professors Duke, J. C. Othus (Oregon State Col.) and Harmer E. Davis, respectively. The paper, Anlaysis of Three-Dimensional Stress Problems by Photoelasticity, by R. Weller (Wash. State Col.) attracted considerable attention. The technical aspects of several problems of three-dimensional photo-

elasticity were emphasized by interrogations during the discussion. B. F. Ruffner (Oregon State Col.) suggested outlines and methods in his paper, "A Course in Photoelasticity." M. S. Ketchum, Jr. (Case) indicated his desire to base a course in Photoelasticity on the Theory of Elasticity—eliminating the course thereby from the undergraduate curricula because of the prerequisite rule. He considered the use of strain gages, on actual problems for analysis, desirable in a course in photoelasticity. H. E. Wessman (N. Y. U.), offered to show colored motion picture films in addition to the program. The proposal was gladly accepted. The films depicted photoelastic equipment manipulation and displayed various isochromatic and isoclinic patterns for study. Following the closing paper and discussion on Minimum Equipment and Test Procedure for Photoelastic Studies, by E. E. Weibel (Univ. of Cal.), the meeting adjourned for an inspection trip of the Photoelastic Laboratory of the University of California.

The Annual Dinner of the Civil Engineering Division was in charge of Raymond E. Davis, master of ceremonies. George Pettit, Assistant to President Robert G. Sproul, University of California, related—with fact and anecdote—the colorful History, Growth and Activities of the University of California. Special musical numbers and community singing were arranged and directed by O. S. Zelner of the University of Minnesota. Mrs. Harmer E. Davis was at the piano. Other general, luncheon and business meetings were carried out as shown by the program.

Executive Committee.—The officers for 1940–41 are: L. G. Straub (University of Minnesota), Chairman; E. E. Bauer (University of Illinois), Secretary; F. W. Stubbs, Jr. (Rhode Island State College), Editor; J. S. Dodds (Iowa State College), Harmer E. Davis (University of California) and M. W. Furr (Kansas State College), Directors.

1. *Educational Policy and Teaching Methods.*—Harmer E. Davis, Chairman. An informal meeting of the Committee was held on June 25, 1940. Too few regular members of the Committee were present to transact formal business. However, a discussion was held on the functions of Committee I. It was pointed out that the principal function of Committee I, in common with most other committees of the Division, has been to sponsor programs at annual meetings. Other than discharging this duty, little else is ordinarily undertaken. On the whole, there has been little continuity in the work of many of the committees, especially of Committee I. No records of past committee proceedings have been available. It appeared to be the consensus of those present that in view of the now-crowded programs at the annual meetings, it is

neither necessary nor desirable that each committee present a program at every meeting.

It was suggested by the Chairman that it may be appropriate for Committee I to act the part of a service committee, both with respect to the Division and with respect to the Executive Committee of the Division, to study and report on educational policies such as may affect the Civil Engineering Division and instruction in engineering in general. Such a procedure would lead to a better integrated policy for civil engineering instructors on problems peculiar to their particular field. Current matters for possible action of this sort are as follows: 1. Endorsement of the report of special committee on Aims and Scope of Engineering Curricula (JOURNAL S. P. E. E., March, 1940), if civil engineering instructors are in accord with the policy stated in this report. 2. Consideration of the question raised by R. G. Tyler of the University of Washington, Are we training enough civil engineers? (See *Civil Engineering,* September, 1940, page 604.)

A copy of this letter has been transmitted to the Chairman of Committee I for 1940–41 as a guide for future action of the Committee.

2. *Structural Engineering.*—Under the chairmanship of E. H. Gaylord, this committee was co-sponsor of the program on *Photoelasticity.* In addition to this the following program on structural teaching was prepared. In the absence of the Chairman, F. B. Farquharson (Univ. of Wash.) presided at the conference. The program was as follows: Laboratory Work in the Senior Structural Option, by M. S. Ketchum (Case) and T. H. Evans (Univ. of Va.); Supervised Problem Periods vs. Home Study, H. E. Wessman (N. Y. U.) and F. O. Rose (U. S. C.); Senior Theses, Fred Merryfield (Oregon State Col.) and C. D. Y. Ostrom (Univ. of Cal.). It is regretted that the available space will not permit the inclusion of excerpts of the three papers and discussions of the structural conference. It is presumed that *Editor* F. W. Stubbs, Jr. will find it possible to publish many of the Divisions' papers this year.

Correspondence with H. E. Davis, Chairman of Committee I, was of a thought-provoking nature. He advocates something different for future programs. He suggested dam analysis and design in all its aspects, such as experimental investigations and trial load method mathematical analysis, as being appropriate for discussion in connection with the relation such developments bear to the engineering curricula. He further suggested that the statements of qualified practicing engineers be sought as to the extent of preparation they deem necessary for the graduate along such lines indicated above. Summing up, Chairman Gaylord concludes as follows:

I. There should be some clearing house for the Division which should keep a complete record of topics discussed, not only at annual meetings, but also at various sectional meetings throughout the country. This information should be made available to committee chairmen, and should, if possible, go back about ten years. This will help to avoid duplication of discussions and enable chairmen to immediately rule out proposed discussions which have already been covered. Of course this is not to say that a topic discussed at a sectional meeting should not also be a good topic for an annual meeting, but such a record would be invaluable and once started could be easily kept up to date. It would be a good piece of work for each committee to undertake for next year.

II. A questionnaire (what!—again?) might be sent to members of the division—or to a selected sample—to determine what kind of program they would like to have at the annual meetings. Questions made up from the comments of Professor Davis should be included. Members should be urged to answer the questionnaire, because it will enable persons in charge of formulating programs to arrange meetings which will be of interest.

III. Professor Davis' comments should be given careful consideration by the Division, as our meetings are quite likely to become stale if something stimulating is not done to give them the variety they need.

3. *Sanitary Engineering.*—Edward R. Stapley, Oklahoma A. & M. College, Chairman, presided at the conference and Thomas C. Adams, University of Utah, acted as recorder. The first paper, Teaching the Topic of Surface Runoff in Water Supply and Sewerage Courses was given by Charles Gillman Hyde, University of California. R. G. Tyler brought out in his discussion an outline of the work that may be done, stressing: (*a*) the general relation of the course with other courses, (*b*) the complications that arise in serving students of different curricula, and (*c*) indicating that vested interests in college curricula were impediments. In the absence of Jack J. Hinman, a colleague, F. M. Dawson, University of Iowa, read his paper on Teaching Plant Operation. This discussion was illustrated by lantern slides. W. F. Langelier pointed out the use made of the sanitary engineering laboratories of the University of California. Chairman Stapley discussed the subject of The Sanitary Engineering Curriculum from the Viewpoint of Practicing Engineers. The report on Water and Sewage Short Schools by Stanley and Boyce, mentioned under sub-committee reports above, concluded the meeting.

4. *Transportation.*—In organizing its work for the year, the Transportation Committee faced the fact that numerous colleges

represented within the membership of the Society were giving less consideration to the teaching of subjects designed to prepare students to enter the service of transportation agencies, principally the railways, because of their experience that these agencies were no longer employing their graduates in the numbers that they once were.

The committee faced the further fact that while some railway executives are alert to the need for bringing young men with college training into their ranks and are offering these men opportunity for advancement comparable with other industries as they demonstrate their fitness, the large majority of railway officers are critical of the colleges for continuing to train men for a construction era that has ceased to exist and for failing to prepare their graduates for railway operation as it prevails today, and are not therefore as sympathetic to the enrollment and recognition of college graduates in their organizations as might be desired.

It appeared essential to the committee, therefore, to bring these two points of view together in order to reconcile them and determine what changes the colleges should make in their courses of training to eliminate the objections raised by prospective employers and reopen this outlet for their graduates. For this reason the committee departed from the general practice of building a program around discussions of teaching technique and brought before those interested in teaching, four prominent engineering executives in railway and highway organizations to tell our members what their industries require in college graduates and what these graduates may expect in this service.

Because the greatest falling off in the employment of engineering graduates has occurred in railway service, three of the four speakers who were selected to address the group were selected from that branch of transportation. The first of these speakers, J. W. Williams, chief engineer of the Western Pacific Railway, addressed the group on the theme What a Railway Expects in the Engineering Graduate. In this address, Colonel Williams pointed out the changes in the character of instruction that are necessary to prepare the graduate to cope with the problems of railway reconstruction and intensive operation that prevail today, in contrast with those of pioneer construction into new areas that predominated a couple of decades ago.

M. C. Blanchard, chief engineer, Atchison, Topeka & Santa Fe Railway, Coast Lines, speaking on What the Graduate Can Expect in Railway Service, pointed to the many men in high executive as well as engineering positions on the railways today who, after completing their college work, entered railway service

in subordinate capacities, and drew the conclusion from this fact that the railways offer young men of requisite ability, proper training and willingness to serve adequate apprenticeship, opportunities comparable to and even greater than those existing in many other industries.

W. H. Kirkbride, chief engineer of the Southern Pacific, Pacific System, followed with an address on After Graduation, What? in which he emphasized the fact that the college graduate can expect no favors in industry but must be prepared to begin at the bottom and work his way up the ladder through demonstrated merit. He added that, to such a man, a college education gives an advantage that should and will bring recognition.

John H. Skeggs, district engineer, Division of Highways, State of California, described the rapid growth in highway transportation and the necessity for increased facilities and showed the opportunity for engineering direction of these vast expenditures, which in turn shows the opportunities presented to the engineering graduate.

The Transportation Committee then presented its report summarizing the changes that have occurred in the various forms of transportation in recent years and outlining the work that is being carried on in the S. P. E. E. and other associations to adapt the training of the student to the needs of the industry. It concluded with the following recommendations:

(1) That the personnel of the committee be enlarged to include at least one representative from each college or university that offers definite preparation for service with the railways, highways, waterways or airlines. In view of the abandonment of such courses by a number of schools in recent years, it is not believed that this would result in an unwieldy committee. This enlargement of the committee would broaden its thinking and hasten acceptance of its conclusions.

(2) That the work of the committee be made more continuous by reducing the turnover thereon. The present practice of changing a third of the membership each year makes difficult the prosecution of studies that, by their nature, must extend over two or possibly three years.

(3) That the committee organize into subcommittees, each to undertake a specific study. Two such studies suggested are:

(*a*) to determine what the transportation agencies desire in their graduates in the way of training and what further opportunities they can offer graduates so trained—this study to be subdivided between the various transportation agencies, such as the railways, the highways, etc.

(*b*) to study the curricula and teaching materials now offered students preparing for transportation service as well as those who desire fundamental information regarding the place of transportation in industry preparatory to entering industry, to determine the extent to which they meet the present-day requirements of these agencies and also where and in what ways they should be revised.

(4) That the committee establish contact with the similar committee of the A. R. E. A. on Coöperative Relations with Colleges and Universities, and with the Educational Division of the American Road Builders' Association, looking to possible collaboration in their similar and largely common work.

(5) That the committee consider the feasibility of arranging a conference with college and industry leaders to consider the problems of Training for Leadership in Transportation—this conference to be largely attended and to comprise a forum at which both the needs and the means would be discussed. In general character, it might be largely similar to the annual conferences on Transportation sponsored by the University of Nebraska or the hydraulic and other conferences sponsored by other committees of the S. P. E. E. from time to time.

5. *Applied Hydraulics.*—N. A. Christensen, Colorado State College, presided at the meeting at the request of Chairman W. M. Lansford, University of Illinois, who was unable to be present. The items of the meeting were as follows:

First: Report on Survey on a Single First Course in Fluid Mechanics for All Engineering Students, by Charles L. Barker, State College of Washington, Sub-Committee D–1A, Applied Hydraulics Committee, Civil Engineering Division, S. P. E. E. F. M. Dawson, University of Iowa, discussed Mr. Barker's paper and during the discussion, described the reorganization of the first course in hydraulics at the University of Iowa. During the course of the discussion, it was suggested that next year the University of Iowa be requested to report on the outcome of this reorganized course.

Second: R. A. Dodge, University of Michigan, was scheduled to give a paper—Unorthodox Laboratory Course to Accompany Elementary Fluid Mechanics. Professor Dodge was not present at the convention and the printed copies of his paper arrived too late to be included in the program. It was indicated that this paper would be available and copies may be obtained by request.

Third: Report and Recommendation of Committee on Coöperation with National Societies, by Sub-Committee D–2. J. G. Woodburn, Chairman, was unable to be present to present this paper.

Furthermore, neither of his associates in this committee were able to attend the convention. His paper was, therefore, read by W. O. Wagner, University of Nevada. Professor Wagner was, some years ago, one of Chairman Woodburn's students, and his willing assistance was appreciated by those present at the convention.

Fourth: Report of Committee V, Applied Hydraulics, 1939–40, by Glen N. Cox, Louisiana State University. This report suggested a program for future study. It was moved by Dr. Straub, University of Minnesota, that this report be accepted by the Applied Hydraulics Section and passed on to the new officers for the coming year for their consideration in building the program for 1940–41.

The enlargement of the Committee to nine members has some drawbacks. It is difficult to get all members to work. In a smaller committee, seven members as formerly, nearly every member of Committee V would head a small sub-committee which would be made up of other than Committee V members and would therefore put more men to work than the large committee whose membership must necessarily be made up of its own members. Also the small sub-committees do serve as a proving ground for Committee V membership.

6. *Construction Education.*—The Conference was called to order by M. I. Evinger, University of Nebraska, who presided in the absence of H. W. Howard of Idaho. The papers as scheduled in the program were presented: Estimating and Cost Analysis, by C. A. Mockmore (Oregon State College) and Cost Estimating from the Contractor's Standpoint, by G. K. MacDonald, of MacDonald & Kahn, San Francisco. After considerable discussion of the formal papers, two sub-committee reports were given: Survey of Employment of Engineers in Construction Industries, read by C. A. Mockmore in the absence of the sub-committee members; Survey of Content of Courses in Construction Education, by M. I. Evinger, University of Nebraska.

7. *Foundations and Soil Mechanics.*—Frederick J. Converse, California Institute of Technology, conducted this meeting. Chairman P. C. Rutledge, Purdue University, was unable to attend. The following papers were presented. Discussion was confined to minor questions. (1) What Should Every Civil Engineering Graduate Know About Soil Mechanics? by Thomas E. Stanton, Jr., Materials and Research Engineer, California Division of Highways. (2) Some Outlines for an Introductory Course in Soil Mechanics: A Comparison of Methods of Presentation, by R. G. Hennes, University of Washington. (3) The Use of the Laboratory in Teaching Soil Mechanics, illustrated by an inspection trip to the Soil

Laboratory of the University of California, by Harmer E. Davis, University of California. A very instructive trip was conducted by Professor Davis through the soil laboratory.

8. *Surveying and Geodesy.*—Douglas S. Trowbridge, New York University, Chairman. The following papers were presented at the conference. (1) Surveying and mapping conferences sponsored by Committee VIII—Their Purpose and Accomplishments by George H. Harding (Univ. of Louisville) and H. M. Dibert (W. & L. E. Gurley). This paper was read by Mr. Dibert. (2) The California-Nevada Boundary Line by Francis S. Foote (Univ. of Cal). (3) The Place of Surveying in the Civil Engineering Curriculum—a report of the committee—by Douglas S. Trowbridge. This paper was read by Thomas C. Adams (Univ. of Utah). At the close of the conference Milo S. Ketchum, Jr., extended an invitation to all members to attend the Second National Surveying Teachers' Conference at Camp Case July 30 to August 8, 1940. The Berkeley and Camp Case programs were prepared by their special committee on programs, consisting of Chairman Charles O. Roth, Cooper Union; Thomas C. Adams, University of Utah; Frederick H. Fox, Tulane University and Douglas S. Trowbridge, New York University. In addition to the work of the special committees, outlined below, Committee VIII made an investigation of the importance of surveying to civil engineering graduates. Questionnaires were sent to the graduates of the schools at which the committee members are employed. Frederic W. Welch (Wash. State Col.) sent the same questionnaire to four colleges in addition to the one where he is engaged. Out of the 2800 questionnaires sent out, interviewing graduates of a period of about 15 years, 988 replies were received. The result of this investigation was given in a paper by Professor Trowbridge at the Committee's Conference at Berkeley. Efforts are being made to have this report published in 1940–41.

The Second National Surveying Teachers' Conference.—The Second National Surveying Teachers' Conference was held at Camp Case, Case School of Applied Science, Loudonville, Ohio, July 30 to August 8, 1940. This conference has been proclaimed as "exceptionally good" in its many aspects. The meeting was arranged by the Division's Committee on Surveying and Geodesy.

(1) A meeting of Committee VIII was held during the annual meeting of the Society at Penn. State College, June 22, 1939. An invitation of the Case School of Applied Science to hold the Convention at Camp Case was received and accepted. (2) In the fall of 1939 the following Committees were appointed: (*a*) Arrangements—John S. Dodds (Iowa State) Chairman, Malcolm S. Doug-

las (Case), Geo. H. Harding (Univ. of Louisville), Charles O. Roth, H. Oakley Sharp (Rensselaer Poly. Tech.) and Douglas S. Trowbridge. (*b*) Program—The personnel of this Committee is included under paragraph 8 above. (*c*) Rules and Regulations for Regional and National Conferences. Chairman, Geo. H. Harding, Herbert M. Dibert, Thomas C. Adams, Frederick H. Fox and Marion W. Todd (Purdue). This Committee presented a preliminary report at the Annual Meeting at Berkeley. Their final report was given at the meeting at Case Camp and unanimously accepted. The program will not be outlined in this review—in all, seventeen papers were presented.

The following resolution was passed:

WHEREAS, The United States, a leading, powerful, and growing nation with a great variety of public works projects constantly going forward and further developing the country, and

WHEREAS, Our terrain is only 25 per cent adequately mapped and at least 50 per cent of our country is not covered by topographic maps of any kind, and

WHEREAS, Adequate maps are recognized by all leading administrative officials, engineers, and other public spirited persons as necessary to obtain the physical facts regarding our land as essential to all long range planning, national defense, public works, flood control projects, and all others dealing with the use of land, therefore be it

Resolved, That the Second National Surveying Teachers' Conference in session at Camp Case, Loudonville, Ohio, August 1940, hereby heartily endorses the joint report of the Secretaries of the Departments of War, Commerce, and Interior, known as Senate Document No. 54, regarding the adoption of a mapping program with the recommendation that this program be fully adopted at the earliest possible time by the appropriation of the funds necessary therefor.

Conference on Soil Mechanics and its Applications.—Committee VII of the Division on Foundations and Soil Mechanics sponsored a Summer Conference at Purdue University, West Lafayette, Indiana, September 2 to 6, 1940. The Society and the Division are indebted to President Edward C. Elliott and A. A. Potter for Purdue University; to R. B. Wiley for the School of Civil Engineering; to W. A. Knapp for the Engineering Extension Department and to K. B. Woods for the Joint Highway Research Project. Credit is also due to the members of the Committe, and particularly to P. C. Rutledge, *Chairman,* for the success of the conference.

The meeting opened with a general session Monday morning in the usual manner; closing with a timely discussion of the subject

of Soil Conditions and Soil Mechanics in Mexico City given by A. E. Cummings, Chicago. The meetings were all more or less technical. The sessions were indicated on the program as Sections with subjects as follows: Section I (two sessions)—The Scope of Soil Mechanics and Soil Mechanics Instruction. Section II—Practical Engineering appraisals of Soil Mechanics. Section III—Sampling, Identification, and Classifications of Soils. Section IV—The Physical Properties of Soils and their Determination. Section V—The Mechanics of Rupture in Soils. Section VI—The Mechanics of Deformation in Soils Section VII—(the two sessions listed were combined)—Soil Mechanics Applied to Highway Engineering.

The "Proceedings" of the conference were pre-printed. Copies are available at four dollars per copy. There was intense interest in the formal papers and discussions. Informal conferences were scheduled in the Laboratories where demonstrations of various soil investigations were expounded.

There were 203 registrations of 34 states and 3 provinces in Canada, and New Zealand. Of the number present, 100 were engineering teachers; including 8 heads of departments and deans from 45 universities, colleges and engineering schools. Finally, in order of the engineering branches represented, there were 46 highway engineers, 19 consulting engineers, 17 U. S. Department Engineers, 11 representative of materials and equipment producers, 6 engineers Department of Subways of the City of Chicago and 4 engineers of U. S. Government agencies not listed above.

Notes and Summary.—The work of the Civil Engineering Division for the 1939–40 year provided studies in practically all branches of civil engineering teaching. Some suggestions and criticisms were received from committee men and members. Also, some opinions of the Division's annual program are expressed in the body of this report. The writer is not in accord with all of the suggestions or criticisms as received.

The founders of the Division, and their recommendations of 1934 approved by the Society, established a plan of organization unique perhaps in some ways, that has ostensibly passed the *test of time.* The Division has fulfilled its purpose satisfactorily. Ref. *Civil Engineering Bulletin,* V. 4, May 1939, page 3 and S. P. E. E. JOURNAL OF ENGINEERING EDUCATION, V. 31, September 1940, page 78. Is it not true that: the committees are about right in size—there are a sufficient number of them—three-year terms are satisfactory—three new appointees each year continues the work—most of the appointees coöperate and work dilligently—the programs are of average quality or better—continuity of work in all cases is not always essential—any reasonable subject-matter can be

incorporated in a satisfactory program, and what-have-you; indicating that the Division has had an unqualified success. The organization as originally set forth and its scheme of operation may not be materially improved upon. This is the opinion of many members.

It has been suggested that a Constitution and By-Laws be adopted. Paul P. Rice, Executive Secretary 1939–40, took up the task, wrote and circulated a Constitution and By-Laws but no official action has been taken upon the *work* he submitted. The sentiment, informally expressed by some members, was quite unfavorable to the particular piece of work. The objection being that it was too explicit and would be unwieldy. Perchance, this problem will be cared for by the 1940–41 Executive Committee although it is not considered to be of extreme importance. The success of the Division is but little dependent upon the mere fact that it approves and operates under a Constitution and By-Laws.

The Executive Committee of the Division should function at all times *in close touch* with the Officers of the Society and confine all activities within the bounds of the policies of the Society. The objectives should be mutually understood, particularly by the officers of the division and the Committee leaders. In consequence of these questions, the outgrowth of an expanding program year-by-year, President Donald B. Prentice has appointed a Committee to study the Relations of Divisions of the Society as a means to equate our endeavors.

M. W. Furr,
Chairman, 1939–40

The **Electrical Engineering Conference** was held on June 24. Over 45 members were in attendance at each of the two sessions. Knox McIlwain, University of Pennsylvania, presided in the absence of the regular chairman, George W. Swenson, Michigan State College of Mining and Technology. A telegram was read stating Professor Swenson's regret for his inability to attend the meeting.

The morning session was devoted to a discussion of the arts and techniques in good teaching. The group was fortunate in having the views of an educator, Dean Frank N. Freeman, College of Education, University of California, ably presented in his paper, Fundamental Principles for Good Teaching. Ideas and practices of engineering educators were set forth in the papers, Education versus Induction, by Harold Pender, University of Pennsylvania, and Education from the Viewpoint of the Electrical Engineering Department, by Lester E. Reukema, University of California. Dean Pender's paper was read by Knox McIlwain.

There was active and illuminating discussion of these papers. Among those taking part were the following: Robert C. Disque, Drexel Institute of Technology; James C. Clark, University of Arizona; E. W. Schilling, Montana State College; Edgar A. Loew, University of Washington; Donald S. Bridgman, American Tel. and Tel. Company; Albert L. Taylor, University of Utah; S. B. Talmage, New Mexico School of Mines; W. Clinton DuVall, University of Colorado; Ralph W. Tapy, University of New Mexico; Erwin K. Rohr, North Dakota Agricultural College; Edwin E. Clark, South Dakota School of Mines.

The afternoon session was devoted to consideration of the proper content of an electrical engineering curriculum in a changing world. The conference was enlivened by the hearing of both industrialists and engineering educators. The paper, Electrical Engineering Curriculum from an Industrial Viewpoint, by J. H. Belknap, Westinghouse Electric and Manufacturing Company, was read by A. W. Copley of that Company. The attitude of L. M. K. Boelter, University of California was presented in his paper, Liberal Choice of Electives Should Be Provided in the Engineering Curriculum.

Many who contributed to the discussion in the morning were again heard and in addition the following made statements: Edmund D. Ayres, University of Wisconsin; Fredrick C. Lindvahl, California Institute of Technology; Charles H. Dawson, University of Rochester; James H. Weaver, Ohio State University; D. P. Savant, Georgia School of Technology; Ernest A. Valade, Catholic University of America; C. F. Dalziel, University of California; Philip S. Biegler, University of Southern California.

The dinner meeting was held at the Claremont Hotel with over 40 members and guests present. The nominating committee of Deans Disque and Loew presented the following slate, the election of whom was by unanimous acclamation.

Chairman, Knox McIlwain, University of Pennsylvania
Vice Chairman, A. L. Albert, Oregon State College
Secretary, M. S. Coover, Iowa State College

Entertainment was provided by Professor and Mrs. Raymond W. Ager in the showing of beautiful colored slides of a hiking or mushing-in trip into the high Sierra-Nevada Mountains. On this trip their party was the first to break into valleys and canyons that had been snowbound all winter.

On Tuesday a joint meeting was held with the Industrial Engineering and Physics sections while on Thursday a meeting was held with the Engineering Economy section. At both of these meetings

a large portion of those present were men whose primary interest is electrical engineering.

HARRY S. DIXON,
Acting Secretary

The importance of **Engineering Economy** was evidenced at the Berkeley meeting by the ever growing number of sessions dealing with it. The first of these was held Monday morning, jointly with the civil engineers, presided over by Charles A. Mockmore of Oregon State College. The first of two papers was Economy Studies in Public Works, by Edward Hyatt, State Engineer of California, and Raymond Matthew, Supervising Hydraulic Engineer of the California Division of Water Resources. Read by Mr. Matthew, the paper stressed the authors' experience that greater and more competent economic analysis is required for public works today, and that public projects should be made to meet such criteria as: overall economy, most economic alternative, and practical conformance of amortization to financial obligations. The second paper was Teaching Public Works Economy, by Thomas C. Adams, of the University of Utah. Engineering economy was advocated as a separate specialization parallel to mathematics or structures, including not only theory but some pragmatic approach to finance, as well as a cautious evaluation of the irreduceable factors so often abused in public administration. The ensuing discussions, led by S. B. Morris of Stanford University and Franklin Thomas of the California Institute of Technology, agreed generally that quantitative economic analysis was today mandatory in engineering practice and education. Others entering the discussion from the floor were: F. M. Dawson, E. D. Ayres, F. A. Russell, C. A. Mockmore, M. I. Evinger.

The second meeting on Monday was a joint luncheon with the industrial engineering group. E. L. Grant of Stanford University was chairman. The speaker was B. E. Goetz of the Armour Institute of Technology who discussed The Relationship of Cost Accounting and Engineering Economy. His thesis was that a new accounting for engineers should be developed to replace entirely the older conventional type, tracing the economic substance rather than the financial shadow of enterprise. Considerable discussion made for a most interesting meeting.

The third meeting on Thursday, with E. L. Grant as chairman, was again a joint session with the mechanical and electrical engineering groups. The first speaker was Andrew I. Peterson of New York University, whose paper, Economics in Mechanical Engineering, rationalized the degree and character of technical-economic

training considered proper for the undergraduate engineer from the viewpoint of available time and subsequent practice. The second paper was An Industrial View of College and Post College Engineering Education, prepared by R. C. Muir of the General Electric Company and read by A. G. Jones of the same company. It was advanced that engineering schools should emphasize sound training in fundamentals preparatory to post graduate training in either our graduate schools or industry itself. The discussions were led by W. H. McBryde, president of The American Society of Mechanical Engineers. Those participating from the floor included: A. L. Townsend, Knox McIlwain, E. L. Grant, P. T. Norton, J. C. Clark, L. P. Alford and B. E. Goetz.

As a whole, the conferences were highly successful with a most encouraging attendance. Substantial evidence indicated that the subject was now a fundamental one in all branches of engineering, best taught by engineers specifically prepared in the field. The Engineering Economy Committee held its meeting late Thursday afternoon, summing up the accomplishments of the meeting as a whole and extending thanks to its chairman, E. L. Grant, for his significant work in development of both subject and programs.

The secretary wishes to note with thanks the assistance of E. L. Eddy of the Case School of Applied Science in recording the proceedings of the joint conference with the mechanical and electrical engineering groups. In the interest of condensation, the undersigned has taken the liberty of incorporating his notes herewith.

ANDREW I. PETERSON,
Secretary

As its major activity of the year, the **Committee on Engineering Research** compiled a list of the titles of graduate engineering theses which were submitted in American engineering schools during 1938–1939. Data were submitted by 73 colleges and universities and a total of 1141 thesis titles were classified and reviewed by the Committee. Nowhere else, so far as we know, is there available such a list of substantially all graduate engineering theses submitted in any one year. The Committee has analyzed the list of titles according to subject matter, function or type of work, and statistically in various ways.

In submitting this report the Committee desires to emphasize that undue weight should not be given to, and unjustified inferences should not be drawn from the statistical summaries nor from the list of thesis titles. The Committee wishes to stress its belief

(1) that this list of unpublished researches may be helpful in locating potential research workers and research facilities in relation to national defense, and

(2) that to each individual supervisor of graduate student research the list of theses may serve as a kind of yardstick of accomplishment and as a stimulus to improvement in some phases of graduate work in engineering.

The Committee is unanimous in its recommendation that the final report, dated October 14, 1940, (with its two appendices) be recommended for publication by the Society. (The Publication Committee of the Society is now considering this recommendation.)

At the meeting in Berkeley, the Committee on Engineering Research sponsored one conference jointly with the Civil Engineering Division and the Mechanics Division on the topic The Place of Photoelasticity in the Civil Engineering Curriculum. The Committee sponsored a second conference focusing on the direction and administration of research and on a summary of current graduate research in American engineering schools. H. A. Vagtborg, Director, Engineering Foundation of Armour Institute of Technology, presented a paper on Our Research System which has been recommended for publication for the Society. The chairman presented a progress report under the title Whither Graduate Research . . . A Summary of Titles of Graduate Engineering Theses Submitted in 1939 which is being submitted separately for further consideration by the Publication Committee of the Society.

F. T. MAVIS,
Chairman

The session on **Coöperative Engineering Education** was held at 2 o'clock in Room 201, Wheeler Hall, on Tuesday, June 25th, George W. Burns, University of Cincinnati, presiding. Robert C. Disque, Drexel Institute of Technology, presented a paper Extension of the Engineering Curriculum and its Relation to Cooperative Work. Discussion of Dean Disque's paper developed the following points:

(1) The liberal outlook and viewpoint apparently cannot be imparted by formal courses exclusively but requires auxiliary exercises and assignments. A reading program during work periods should accomplish much in this direction.

(2) The Drexel Plan for reading during work periods requires an especially capable and dynamic faculty leader.

(3) Fifth year programs in the curriculum devoted exclusively to cultural subjects have not been a great success.

George M. Maney, Northwestern University, presented an address prepared by Dean Ovid W. Eshbach, entitled Cooperative Courses at the Northwestern Technological Institute. Discussion

of Dean Eshbach's paper soon led to a consideration of the effect of union activity upon the employment of coöperative students in industry. In answer to questions in the matter, statements were made from the floor as follows:

(1) Drexel Institute has encountered no difficulty in the placement of students who have considerable academic ability but seem to be badly adapted for employment. Adjustment can always be obtained by a study of the individual student. Industrial requirements differ considerably and must be thoroughly understood by the coördinator and taken into account in his study of the individual student characteristics.

(2) No formal relations with unions concerning student employment have been made at Northwestern University, nor are they contemplated.

(3) Drexel Institute makes an agreement with unions that no picketing will be required of them if they are required to join a union in order to hold their jobs.

Following the conclusion of the discussion, the business meeting of the Division was held. In this meeting, Ovid W. Eshbach was elected chairman of the division for the coming year. It was voted that he should be given the opportunity to name a secretary for the division.

C. J. FREUND,
Acting Secretary

In the first meeting of the **English** section, H. L. Creek, Purdue University presiding, Amy V. Hall, University of Washington, gave a stimulating paper on English as a Catalyst in which she noted the present tendency for science to outstrip democracy, and the additional burden thereby placed upon English teachers in engineering schools. Miss Hall pointed out the strength of the engineering student in his habits of exact thinking, his enthusiasm, and his excellent instruction in technical subjects, offset against the long hours, rigorous curriculum, and materialistic viewpoint inherent to his training. As a means of using the strength to overcome the weaknesses, Miss Hall gave a comprehensive plan of reading and discussion calculated to spread the intellectual horizons of the technical student, and to introduce him to attitudinal as well as informational reading.

J. E. Thornton, University of Michigan, gave a resume of a recent study on the problem of teaching report writing in technical schools. The study indicates most of all that report writing is taken seriously and that teachers of report writing are inadequately trained. While occasionally report courses are given by

engineering instructors, the large burden falls upon teachers of English. Professor Thornton finds that instructors in report writing have difficulty in getting coöperation from technical instructors in actual teaching, but that the attitude of the technical instructor is always good. He feels also that non-technical material is often usable in teaching the form and organization of a report. Since the methods of teaching report writing vary so widely, it is suggested that one session of the English group next year be devoted to a symposium on that problem.

F. R. Johnson, Stanford University, in his paper defended the teaching of fundamentals of composition rather than any more specialized forms usually included in courses in so-called "engineering English." Dr. Johnson pointed out that the conflict between the two types of courses is the old fight between the immediate versus the general, in which the general is always the ultimate victor. In support of his thesis, Dr. Johnson noted that many engineering graduates enter administrative or other positions in which specialized report forms are not applicable; that forms and organization of technical papers are comparatively easy to learn after one knows fundamental composition; that undergraduates are not mature enough to appreciate the need for report writing or other special forms; and that they lack the audience appeal or other motivations inherent to actual professional situations. The special forms of writing he believes are comparable to the "handbook" training of journeymen as contrasted with the basic training of the professional engineer.

In the Tuesday session, M. E. Manning, Westinghouse E. & M. Co., and W. G. Crouch, University of Pittsburgh, gave a joint illustrated lecture on methods now in use for teaching writing to graduate students employed by Westinghouse. The regular logical procedure of the engineer in locating short-circuits is applied to the loss of transmission of thought by poor English. Here the student uses his regular thought paths to reach an end now highly motivated by actual experience. Often, in undergraduate classes, Dr. Crouch indicated, the student works in a vacuum, while in the Westinghouse laboratories he meets actual professional conditions. The course is accepted for graduate credit at the University; it places emphasis on the shorter, or letter type of report; and it is given in such a way as to encourage younger men to overcome embarrassment in the presence of older men.

C. K. Judy, California Institute of Technology, gave a most inspiring paper on Literature and the Engineer in which he pleaded for more pure literature courses as a means of teaching literacy, the ability to judge figurative language, and the habit of reading. In

his work he gives emphasis to the writings of the Nineteenth and Twentieth centuries, and to the contemporary essay of opinion. While the total time a technical student may give to literature may be limited, he may still learn to appreciate its beauties without heavy critical technique, just as he may see the beauty of a flower without a botanist.

During the remaining part of the afternoon session, Dr. Creek made preliminary discussion of plans for a special summer school for teachers of English in engineering schools. Miss Hall was chairman of the Tuesday meeting.

At the dinner meeting, Tuesday evening, W. Otto Birk, University of Colorado, presiding, the principal order of business was a review and discussion of the extensive report recently made by a committee on the teaching of English in engineering schools. The discussion was led by Karl O. Thompson, Case School of Applied Science, who gave much detail of the personnel, aims and attitude of the committee, as well as its findings. He made it clear that the study was based on a feeling of encouragement rather than discouragement, and on positive rather than negative approach. Its conclusions and recommendations are definite; yet many additional things remain to be done. Since copies of the study are in the hands of most of the members of the English group, Professor Thompson did not go into detail about the actual contents.

L. M. K. Boelter, University of California, made discussion of his course in writing and general philosophy. The purpose of the course is not only additional training in writing and speaking, but also enlarged cultural and intellectual horizons, as well as supplementary subjective and objective understanding of personality. Professor Boelter feels that colleges are doing too much elementary work in an effort to reach down to the levels recently lowered in the secondary schools.

Dr. Creek continued the discussion of the afternoon on special training for English teachers in engineering schools. He indicated that a coöperative plan has been worked out whereby Massachusetts Institute of Technology and Harvard University will give such training, but that the success of plan depended upon engineering schools who will join in the plan by enabling English instructors to participate in the program.

Conferences of the English section were well attended and the discussions after each paper were unusually good.

A. M. FOUNTAIN,
Secretary

The Committee on **Evening Engineering Courses** met in Berkeley for the purpose of discussing plans and programs and agreed upon the following conclusions:

The interest and work of the Committee should be primarily directed toward the study and consideration of engineering courses of college grade.

The problems and policies surrounding the academic standards of evening courses are the principal fields of interest to the Committee.

There is need for a distribution of factual information concerning the work of the evening schools.

It seemed improbable that there was enough interest in the field of evening instruction to warrant the recommendation of a division in that field but the Committee considered it desirable to meet annually at the time of the Convention to discuss common problems and present papers that might be prepared upon the various aspects of these problems.

H. S. ROGERS

The **Industrial Engineering Division** met with the Engineering Economy Committee on June 24. Thirty-two members were present. E. L. Grant, Stanford University, Chairman of the Engineering Economy Committee, presided.

Billy E. Goetz, Armour Institute of Technology, gave a very interesting paper on The Relationship of Cost Accounting and Engineering Economy. Mr. Goetz' address, well written and well delivered, being on a controversial subject, gave promise of a healthy discussion. Time forced Chairman Grant, however, to rule *No Discussion,* and a wonderful opportunity for a spirited "give and take" was lost.

The Division met with the Mechanical Engineering Division in a joint session on Manufacturing Processes. Thirty-six members were present. A. B. Domonoske, Stanford University, presided.

A paper on Teaching Materials in a Process Course by Peter E. Kyle, Massachusetts Institute of Technology, was read. Prepared discussions by D. S. Clark, California Institute of Technology, O. W. Boston, University of Michigan, E. J. Ash, University of Michigan, and J. E. Dorn, University of California, were read.

The Standard Gage Laboratory was given by Merrill S. Hugo, Stanford University. The Gage Laboratory described was the one at Stanford, a U. S. Ordnance Department installation. Floor discussion was all on the Gage Laboratory and centered on questions covering Ordnance technique.

The Division met with the Chemical, Electrical, Mechanical, and Mineral Technology Divisions in a joint session June 25. Thirty members were present. L. P. Alford, New York University, presided.

The subject was The Place of Management Training in Engineering Curricula. Two excellent papers were given, one by J. C. Clark, University of Arizona, the other by E. P. Degarmo, University of California. The papers were followed by interesting discussions from the floor. Those participating were: H. S. Dixon, Purdue, J. W. Hazen, Los Angeles City College, P. T. Norton, Virginia Polytechnic Institute, H. F. Venter, Stocton Trade School, E. L. Grant, Stanford, L. E. Reukema, University of California, W. G. Angermann, University of Southern California, and the chairman L. P. Alford.

An Epicurean treat in the nature of a California turkey dinner was enjoyed at the Claremont Hotel in conjunction with the Mechanical Engineering Division, the host, and the Labor Relations Committee as fellow guests. There were sixty-three present. C. H. Casberg of the Mechanical Engineering Division, University of Illinois, presided.

The inimitable Dean Kimball had a few words to say, and he said them as they should be said.

Warren H. McBryde, President of the American Society of Mechanical Engineers, gave the address of the evening. His talk accented the value of fundamentals in engineering training. It was illustrated by many personal experiences, always tieing back to the great debt he owed Auburn for the training he had received there in his undergraduate days.

The Labor Relations Committee met with the Industrial Engineering Division at a joint session on June 27. Forty-two members were present. Chairman G. L. Sullivan of the Labor Relations Committee, Santa Clara University, presided.

In the absence of H. E. Brillhart, Secretary, California Gas and Electric Employees Union, Emil N. Ott, assistant to Mr. Brillhart, read Mr. Brillhart's paper on Independent Unions.

Chas. J. Janigan, Counsel of the San Francisco Labor Council, substituted for John R. O'Connell, Secretary of the San Francisco Labor Council, and gave a talk from notes on the A. F. of L.

John Riffe, District Director, Steel Workers Organizing Committee, was sick and no paper or talk was given on the C. I. O.

Wm. G. Storie, an associate of Almon E. Roth, Manager of the San Francisco Employers Council, substituted for Mr. Roth and gave a paper on Employers.

F. A. Magoun, Massachusetts Institute of Technology, gave a paper on Methods of Teaching Labor Relations.

Discussion from the floor centered around the Magoun paper and was participated in by J. R. Bangs, Cornell, L. M. Gilbreth, Purdue, C. J. Freund, Detroit and S. W. Dudley, Yale.

H. J. McINTYRE,
Secretary

The Committee on **Instructional Methods** scheduled one dinner meeting and two conference periods for the third annual program of this Committee.

At the dinner meeting, attended by members and wives, Chairman Carl S. Ell, Northeastern University, presided. Following an interesting musical program, arranged by a local committee, the Chairman introduced Dexter S. Kimball, Cornell University, who addressed the group on the subject, The Vital Spark in Teaching.

Based on a long period of administrative and teaching experience, the speaker asserted that, in his judgment, engineering teachers measure up favorably in comparison with teachers in all other groups. He prescribed the requisites of good teaching by references to methods of instruction, the importance of a thorough knowledge of the subject, zeal in maintaining a high order of scholastic effort throughout the entire period of active service of the teacher, superior ability in language, in speech, and in the command and use of an extensive vocabulary. These are all qualifications of a good teacher. However, a teacher who possesses also the vital spark in teaching would exhibit superior qualifications. The vital spark in teaching, the speaker stated, is difficult to describe and evaluate, but it is easy to recognize.

The luncheon meeting program was in charge of the Subcommittee on Visual Education consisting of Theodore H. Morgan (Chairman), William R. Bryans, Raymond D. Douglass, Justus Rising, and George E. Tomlinson.

Chairman Theodore H. Morgan, Worcester Polytechnic Institute, presided at the luncheon meeting and opened the program by reading a preliminary report of an investigation conducted by his committee. This report was based on questionnaires, answered by 89 institutions to determine the opinion of engineering faculties regarding the value of motion pictures in engineering training. It is stated in the conclusions of this report that " a study of the replies received shows that this is a new field in which very little has been done to date. A few enthusiasts have gone ahead making splendid progress because their experience has convinced them of the possibilities. Such men have produced films adapted to their particular needs and ideas and have been amply rewarded by the results. Others who have produced only one film or animated di-

agram have also become enthusiasts. On the whole, there appears to be considerable interest in the subject. . . .

"Technique in the motion picture industry has progressed to its present degree of perfection largely as a result of engineering, but its main field of utility has been in public entertainment. The replies and comments received from colleges indicate that the engineering profession is only beginning to realize the possibilities of this art as a powerful educational factor. The Committee has been able to do little more than survey the field during the past year, but believes that ways and means can be found to render concrete assistance in increasing the effectiveness of motion pictures in engineering education."

The second number on this program was a paper entitled Films and Slides as Aids in Teaching Basic Skills in Engineering, by Justus Rising, Purdue University. This paper contained a record of the experience of the author in teaching the following elements of engineering drawing by means of slides, sound motion pictures, and also silent films, with a preference for the latter when correlated explanations and comments are read by the instructor as the film is displayed: free-hand drafting, orthographic projection, auxiliary views, sectional views, pictorial drawing, screw thread representation, structural drawing, developments, and intersections.

The writer states that to witness the pictures illustrating these topics, drawing classes were transferred to a lecture room after which they returned to the drawing room and applied what they had seen to their drawing work. By giving the entire class a demonstration at the beginning of a unit of instruction, the group was able to get away to a quicker start. Furthermore, this relieves the instructor of making repeated individual demonstrations.

In a paper supplemented by illustrations and entitled Films and Slides as Aids in Theory Courses, William R. Bryans, New York University, outlined the experimental work he has conducted with moving pictures for theory courses in engineering mechanics. He cited examples of the use of short animated diagrammatic cartoons as follows: counterbalance of a locomotive drive wheel; development of an involute gear tooth; quick-return mechanism, effect of changing center of rotation of oscillating arm; quick-return mechanism, velocity vectors; aeronautics, conventional angles for yaw, pitch and roll. In structural courses, the author referred to the use of motion pictures to illustrate a photoelastic experiment for the purpose of giving the student a chance to visualize the basic principles involved. Another example was the use of a film illustrating a beam experiment demonstrating Maxwell's theorem of reciprocal displacements. He states that the film is more con-

vincing than an actual experiment performed by a small group. The author states that he is working on a film for use in the first sessions of a mechanics of materials course. This combines animated cartoons with actual pictures of a tension test in a testing machine. Its objective is a visualization of stress and strain relations in elastic materials.

The discussion of the above papers was conducted by John T. Rule, Massachusetts Institute of Technology, and was concerned with the projection of stereoscopic photographs and drawings. He showed a number of Kodachrome stereographs of the San Francisco Fair in order to demonstrate the great superiority in interest value.

He then showed a number of three-dimensional drawings illustrating problems in descriptive geometry, mathematics, and physics. He pointed out the main features of superiority as illustrative material over ordinary drawings and discussed briefly methods of three-dimensional projection and the developments that were occurring in the field.

Herbert J. Gilkey, Iowa State College, presided at the afternoon conference program. All papers and the discussions dealt with the general topic, Relationship Between Classroom and Laboratory Instruction in the following Fields: Chemical Engineering by Carl W. Borgmann, University of Colorado; Mechanical Engineering by Arthur B. Domonoske, Stanford University; Electrical Engineering by Abe Tilles, University of California; Civil and Sanitary Engineering by Richard G. Tyler, University of Washington; and Mechanics by Glenn Murphy, Iowa State College.

In the matter of objectives, principles and administrative procedures governing the relation of laboratory instruction, designed to supplement courses in engineering theory, there are many instances of agreement in the above papers. Each speaker listed the courses in his own field of engineering for which laboratory instruction should be organized.

The following members of the Society discussed the various papers prior to the close of the session: Carl S. Ell, A. L. Taylor, H. J. Gilkey, T. H. Morgan.

A display of models, films, and devices used in the teaching of principles and for demonstrating concepts was exhibited in the Hearst Memorial Mining Building. These models were made available by many colleges through the efforts of William R. Bryans, New York University. The visual material pertained to such a variety of subjects as Aerodynamics, Airplane Spin, Aero-Structures, Descriptive Geometry, Surveying, Field Astronomy, Kinematics, Mechanical Vibrations, Mechanical Drawing, Alternating-Current Theory, Rigid Frame Structures, Electric Waves, Magnetic

Flux in a solenoid, Thermodynamic Gas Surfaces, Rapid Sand Filtration, and Mechanics' Problems.

W. M. COBLEIGH,
Secretary

The **Committee on Labor Relations** held a joint meeting with the Division of Industrial Engineering on June 27, G. L. Sullivan, presiding. Present—42.

A paper, prepared by H. E. Brillhart, Director of Activities of California Gas and Electric Employees Union, Inc., The Independent Union, was read by Emil J. N. Ott, Jr., of the P. G. & E.

In the absence of John R. O'Connell, Secretary of the San Francisco Labor Council, who was to give a talk on the A. F. of L., Charles J. Janigan, Counsel of the California State Federation of Labor, substituted with a 20 minute talk from notes.

John Riffe, District Director, Steel Workers Organizing Committee, who was to give a paper on the C. I. O., was unable to appear due to an emergency operation.

Almon E. Roth, Manager of the San Francisco Employers Council, was represented by Wm. G. Storie, Vice-President of the Council, who presented a 20 minute paper on Employers.

F. A. Magoun then summarized the papers and gave a 30 minute paper of his own on Methods of Teaching Labor Relations. Discussion was centered around Magoun's Paper and was participated in by John R. Bangs, L. M. Gilbreth, C. J. Freund and S. W. Dudley.

H. J. MCINTYRE,
Acting Secretary

The attendance at the sessions of the conference of the **Division of Mathematics** was very gratifying and the discussions were spirited and profitable.

The first session was a luncheon meeting at which thirty members assembled. E. R. Hedrick, Provost of the University of California at Los Angeles, presided. After the transaction of the necessary business of the division two talks were given. The first was by J. H. Weaver of the Ohio State University who emphasized two things: (1) That teachers of mathematics should be careful not to spread the erroneous opinion that the study of mathematics requires a special type of mind, and should go out of their way to explain that mathematical thinking does not differ materially from any other type of thinking. (2) That there is necessity for cooperation between the departments of mathematics and the various technical departments in the colleges of engineering, if the best

possible results are to be obtained. The second talk was given by H. M. Bacon of Stanford University. This talk pointed out the trends in pre-college mathematics. These trends are in general two: (1) Postponement of mathematics instruction by starting the study of algebra in the tenth grade instead of the ninth, thus affording opportunity for only three years of mathematical instruction in secondary schools. (2) The dilution of the mathematical courses already given.

After the reading of this paper G. C. Evans of the University of California presented a resolution protesting against this postponement of mathematics and moved that it be transmitted to the Council of the Society for the Promotion of Engineering Education with the recommendation that it be adopted as a resolution of the Society.

At the second session, which was a joint session with the Junior College group, thirty five persons were present. Three papers were presented. The first one of these papers presented the results of an extensive study by S. E. Urner of what the junior colleges were doing now and what they are likely to do in the future. The information was obtained by personal visits to some ten or twelve junior colleges in southern California and to some of the airplane construction companies. Among the things reported the following seem to be important.

(1) The courses given in mathematics in junior colleges are college algebra, trigonometry, analytic geometry, calculus, vector analysis and differential equations. Only part of the institutions offer work beyond the calculus.

(2) The larger schools are adopting unified courses in mathematics, thus permitting the earlier introduction of the applications which require the calculus.

(3) Terminal courses are being provided to care for the needs of those students who do not care to enter the rigorous training provided for the pre-engineering students. These courses have been fostered by the demands of the airplane construction companies for men of a type between artisan and engineer.

(4) Some schools are also setting up extension courses in cooperation with the Lockheed and Douglas Airplane Corporations. This practice seems destined to grow.

In the second paper of this session Mr. Boselly of the Lincoln High School of Seattle, Washington, described a course in mathematical analysis given to pre-engineering students in the Lincoln High School. The course is given in coöperation with the University of Washington, and college credit is given for it in the University. The experiment seems to be working out well from the standpoint of both the University and the High School.

The third item on the program of this session was a report of the Committee on Junior Colleges. This report, based on replies from seventy-seven colleges, indicated the following things.

(1) A large number of colleges reported an increase in students transferring from junior colleges to colleges of engineering for the completion of their technical work.

(2) There seems to be little coöperation between colleges of engineering and the junior colleges which prepare the students for their later work.

(3) At present there seems to be no tendency to establish a plan of engineering education based on two years at a junior college and three years at a college of engineering.

At the third and last session of the conference forty persons were in attendance. The first paper presented was by Th.v. Karman of California. In this paper Professor Karman presented the essentials of an address made before the Los Angeles section of the American Society of Mechanical Engineers and printed in the April, 1940 issue of Mechanical Engineering. This address stressed the difference in view point between the engineer and the mathematician.

The next paper by L. M. K. Boelter, University of California, described an attack on a problem in heat transfer by means of mathematical analysis. The method went somewhat as follows.

(1) An idealized simple physical situation was set up.

(2) This simple situation was stated in mathematical terms.

(3) The ideal situation was then extended to a more complex ideal situation more closely approximating reality and the problem then handled by more complicated mathematics or by whatever method seemed advisable.

This paper was followed by a report of the Committee on Engineering Problems. This report stated that adequate lists of problems had been compiled for mechanics and electrical engineering, but that there was need for more problems in fluid mechanics, civil engineering, chemical engineering and mechanical engineering. The committee hopes to complete its work in another year.

The last paper on the program was the Chairman's address by C. A. Hutchinson, of the University of Colorado. This paper will be published in a later issue of this JOURNAL.

J. H. WEAVER,
Secretary

The **Mechanical Engineering Division** held one general session to conduct business; a joint session with the Industrial Engineering Division; and one with the Engineering Economy Group.

The Heat Power Group and the Mechanical Laboratory Group held four joint meetings; the Machine Design Group held one meeting; and the Manufacturing Processes Group held one meeting.

Interesting papers were presented at all the meetings and more discussion than usual was heard from the floor. The attendance of the meetings was not as great as last year, but those present seemed to be very much interested and took an active part.

At the annual dinner the officers and committee members for the year 1940–41 were announced.

Ben G. Elliott, University of Wisconsin, presided at the Monday morning joint meeting of the Heat Power and Mechanical Laboratory sections as W. H. Severns was seriously ill and was not able to be present. A. O. Flinner, Kansas State College, acted as recorder.

R. C. Powell, Pacific Gas and Electric Company, presented a paper, Teaching Power Plant Design Based on Process Steam Uses in Oil Refineries. Mr. Powell stressed the importance of the students' knowledge of fundamentals (mathematics, physics, and thermodynamics) and mentioned that the engineers from foreign countries were generally much more able to handle the problems in power plant design engineering than the engineering graduates of the engineering colleges in the United States. Mr. Powell does not advocate a specialized course in power plant design because of the limited number of engineers needed in power plant work.

H. B. Dirks, Michigan State College; A. B. Rice, North Carolina; N. C. Ebaugh, University of Florida; S. J. Tracy, College of the City of New York; A. J. Diakoff, University of North Dakota; and E. Thorkelson, Montana State College, discussed various phases of the paper which added value to this interesting paper.

R. B. Rice presided Monday afternoon at a joint meeting of the Heat Power and Mechanical Laboratory section. A. L. London, Stanford University, presented a paper, Contents of an Engineering Thermodynamics Course. The course described by Professor London at Stanford University is a lecture course offered to seniors and fifth year men working for their engineer's degree. This paper created considerable discussion, for it seems that some present did not think that the teaching of a thermodynamics lecture course would be practicable. N. C. Ebaugh, University of Florida, did not think the course was well correlated with previous work. V. M. Faires, A. and M. College of Texas, was much surprised at the amount of material included and said that it might be better to teach the use of the properties of vapors and gases and heat transfer equations rather than stress too much the derivation of gases. Comments were made as to the type of student for which

the course was designed and whether or not it was better for the colleges to teach on a plane for the better students and allow the others to follow as far as they were able.

The second paper, Heat Power Instruction in Semi-Professional Junior College Courses, by John W. Hazen, Los Angeles City College, was read by H. B. Langille, University of California. This paper created considerable interest since it brought up the type of training that can be done in junior colleges for the young men who have the mental capacity but not the opportunity or the means of attending an engineering college. There is opportunity in industry for men with this type of training, and it seems that junior colleges that provide such training opportunities are doing a valuable service to society.

The annual dinner of the division was well attended. Dean D. S. Kimball, Cornell University, introduced the speaker, Warren H. McBryde, president of the A. S. M. E. President McBryde gave a very interesting address on engineering education based on his vast experience as an engineer.

At the informal luncheon, Thursday, A. A. Potter of Purdue University, awarded the P. G. S. (pretty good scout) to Mrs. C. A. Koepke for her good work at the S. P. E. E. Summer School at Purdue University in 1929. Dean Potter also announced the proposed plans for a S. P. E. E. meeting for Mechanical Engineers at Purdue, following the 1941 annual meeting at the University of Michigan.

The Machine Design section held a joint meeting with the Mechanics Division, on Monday morning, B. M. Green, University of California, presiding. Mr. V. M. Faires acted as the recorder.

Roy Bainer, University of California, presented a paper, Agricultural Machinery Design Techniques. Professor Bainer stated that many factors, such as climate, type of soil, topography, and sales price, affect the design of farm implements and that the basic information that can only be obtained by a scientific analysis is still lacking in a great many problems.

The second paper, Objectives of Instruction in Machine Design, by C. F. Garland and E. E. Weibel, University of California, was presented by C. F. Garland.

The Manufacturing Processes Section held a joint meeting with the Industrial Engineering Division, Monday morning. A. B. Domonoske, Stanford University, presided. F. B. Hays, University of California, acted as secretary. In the absence of P. E. Kyle, Massachusetts Institute of Technology, his paper, Teaching Materials in a Process Course, was read by A. L. Townsend, M. I. T.

The gradual change in the methods of teaching, in the aims and

purposes of engineering shop courses were described in his paper. In a written discussion of Professor Kyle's paper, D. S. Clark, Purdue University, stated that one of the most important factors stressed by Professor Kyle is that of proper organization and sequence of courses and the subjects must be developed logically and in proper order that all courses may be correlated. J. E. Dorn, University of California, presented a written discussion of Professor Kyle's paper. Professor Dorn stated that each college has responded to the change in purpose and aim of shop courses to its individual dictates and that in some respects this was confusing and somewhat undesirable but necessary for progress. Professor Kyle's paper shows what can be done, if some time and thought are expended, to reorganize and arrange process courses so that subjects can be developed logically, in proper order.

The second paper, Standard Gage Laboratory, by A. B. Domonoske and M. S. Hugo of Stanford University, was read by Professor Hugo. An informal discussion regarding the functions of an ordinance department followed.

At the business meeting of the Division at 2:00 P.M., Tuesday, A. B. Domonoske was elected Secretary of the Division for the year 1940–41.

The by-laws of the Mechanical Engineering Division were amended so that the editor of the Mechanical Engineering page becomes a member of the Executive Committee and shall hold office for three years. R. L. Sweigert, Georgia School of Technology, who has been editor of the Mechanical Engineering page during the past year, is now a member of the Executive Committee and shall serve as editor until 1942–43.

As to whether or not the Division should appoint a committee to compile a list of books in the field of Mechanical Engineering was considered, but a motion not to have such a committee, was made and seconded, and the motion was passed unanimously.

R. B. Rice, University of North Carolina, presided at a joint meeting of the Heat Power and Mechanical Laboratory sections on Tuesday afternoon. R. A. Seban, University of Santa Clara, read a very interesting paper, Unit Operation Apparatus in Mechanical Laboratory Instruction, in which he explained how relatively simple and inexpensive experimental apparatus is used for heat transfer, thermodynamics, and fluid flow, and how these experiments on simple systems can be used before proceeding to more complex systems, such as machines and processes. L. M. K. Boelter, University of California, led the discussion of the paper and pointed out the many advantages of the unit operation method.

On Thursday afternoon, at a joint meeting of the Heat Power and Mechanical Laboratory Groups, E. D. Howe, University of

California, presented a paper, Heat Transfer Instruction in Heat Power Courses. R. B. Rice, North Carolina State College, presided. The importance of heat transfer in the technical portion of the mechanical engineering curricula was shown by means of circular figures. A very interesting discussion followed since the unit-operation method is used in teaching heat transfer courses at the University of California.

The second paper, Heat Transfer Instruction in Agricultural Engineering, by F. A. Brooks and R. L. Perry, University of California, brought out many heat transfer problems that prove that heat transfer is one of the primary factors in agriculture. All the biological processes depend upon solar energy, heat exchange between living cells being essential to life, and warm blooded animals must dispose of thermal energy or life ceases. The agricultural engineering students in the University of California pursue the regular mechanical engineering curriculum with no substantial specialization until their senior year when the illustrations and problems are taken from agriculture.

The opening session of the **Mechanics Division** meetings was held jointly with the Machine Design section on Monday morning, Boynton M. Green, Stanford, presiding. The first paper Agricultural Machinery Design Techniques was by Roy Bainer of the University of California at Davis. Professor Bainer showed the necessity of using the engineering approach in problems of design of farm machinery and used as an illustration the work he and his associates have been doing in designing a machine for topping sugar beets. He pointed out the factors of harvesting speed, irregularities in size of beets, and effect of various types of knives. He made the point that the design of farm machinery had been largely empirical, but that further development would have to be made along rational lines. Several details of design of the beet topper were given considerable attention in the discussion which followed, but the most significant comment had to do with the engineering point of view expressed by the author. Not many of those present were familiar with farm machinery and its requirements and were decidedly interested in the way in which Professor Bainer related its design to fundamental principles.

C. F. Garland and E. E. Weibel, of the University of California, presented a paper on Objectives of Instruction in Machine Design. The paper, which was read by the senior author, was a well ordered analysis of the subject. The chief objective was identified as the development of a proper student attitude toward complex problems of design. This attitude was defined as being characterized by a desire to take into account all factors in a given problem and the

desire to understand fully the relationships existing between these factors. The paper also set up as an ultimate goal that all design be placed on a rational basis. Two other general objectives were discussed in the paper. The first of these was that of making the student acquainted with the many various sources of information on machine design and the second was to give him experiences to develop his resourcefulness and powers of analysis and synthesis. In the discussion of the paper, it was brought out that the objectives stated in it might well be broadened to apply generally to engineering education and not alone to machine design. Professor Townsend of M. I. T. spoke briefly to the effect that the paper disclosed that its authors had a broad view of the purpose of the machine design course and that he felt even further emphasis should be given this concept of the course. To this end, he proposed that the title of machine design courses be modified to machine analysis and design. His proposal was not formally adopted, but it seemed the consensus of those present that a machine design course must meet the objectives of the paper by Professors Garland and Weibel in order to be effective. There were approximately thirty in attendance at this conference.

The annual dinner of the Mechanics Division was held at the Claremont Hotel on Monday evening with approximately thirty-five present. A. S. Adams, Colorado School of Mines, chairman of the division, presided and introduced the speaker, Franklin Thomas, California Institute of Technology, who gave a most interesting illustrated address on The Colorado River Aqueduct.

An informal luncheon meeting was held on Tuesday at the Faculty Club with twenty-two in attendance.

The joint session on photoelasticity with the Committees on Engineering Research and Structural Engineering was held Tuesday afternoon, H. D. Eberhart, University of California, presiding. There was an attendance of thirty-five.

R. Weller's paper on Analysis of 3-dimensional Stress Problems by Photoelasticity, presented the theoretical basis, outline of experimental technique, and the general field of useful application of the scattering method of photoelastic study. The prepared discussion of the paper by M. M. Frocht was read by another, because of Professor Frocht's absence. There was considerable informal discussion from the group of the relative merits and proper spheres of usefulness of the several photoelastic techniques.

The paper, read by J. C. Othus, Oregon State College, A Course in Photoelasticity by B. F. Ruffner of Oregon State College presented the lecture syllabus and laboratory outline for a two term course meeting for one lecture hour and one four hour laboratory period per week. The course follows a term course in theory of

indeterminate structures and the three term sequence was designed for those students doing advanced work in strength of materials and photoelasticity. It was brought out in the discussion that the course was an elective one. A feature of the laboratory work is that in the second term it is presented on the project basis. A prepared discussion of the paper was given by M. S. Ketchum, Jr., Case School of Applied Science.

F. B. Farquharson's discussion of the question, Should a Course in Photoelasticity be Given to Undergraduates, centered on the thought that while undergraduates should know something of the photoelastic approach, there is neither need nor time in the undergraduate curriculum for a specialized course in the subject. Professor Farquharson said that he thought all introductory material on photoelasticity could well be presented in two lectures of the customary materials course. General discussion of this question indicated that those present were of the same opinion. R. G. Minarik, Armour Institute of Technology, who was also scheduled to discuss this question was not present at the meeting because of illness. H. Davis, University of California, read his prepared discussion in which he stated that photoelasticity should be given: (1) to competent graduate students and (2) as a "proving ground" course for seniors of exceptional ability.

The paper Minimum Equipment and Test Procedure for Photoelastic Studies by E. E. Weibel, University of California, gave a valuable itemized account of the equipment needed to carry on both instruction and research in the subject.

An instructional film on elementary photoelasticity as used by New York University was shown by H. E. Wessman of that institution.

On Thursday afternoon the Mechanics Division held a conference with A. S. Adams presiding. A sound film Mechanics of Vibration by J. J. Ryan, University of Minnesota, was presented by B. M. Green, Stanford. It showed what might be done in presenting illustrative background material on the important subject of vibration. Professor Green, in his remarks after presentation of the film, said that Professor Ryan had particularly intended that the film be considered suggestive, rather than a formal text book approach.

G. N. Cox, Louisiana State University, gave the paper What is Expected of Fluid Mechanics? In the paper he presented a splendid outline of a basic first course in fluid mechanics upon which more specialized advanced courses in aerodynamics and so on might be based.

The paper Correlation of Courses in Mechanics by J. C. Othus of Oregon State College advanced the thought that considerable

correlation might be obtained by the adoption of standard formal procedures and methods of attack on problems. In his prepared discussion of this paper, N. A. Christensen, Colorado State College, differed with the author and offered the idea that correlation might best be gained by constant references in mechanics courses to the studies the student has previously had as well as by pointing the way to studies yet to be undertaken. There was a lively discussion of this question and a number of those present stated that the matter was of the greatest importance, inasmuch as analytic mechanics constituted the student's introduction to engineering as such.

Following the conference, a short business meeting of the Mechanics Division was held. The motion was made and unanimously passed that "the Executive Committee be authorized to see what can be done to determine minimum essentials of mechanics courses and achievement in the same, the committee to report on this matter at the next annual meeting."

G. P. Boomsliter and E. R. Dawley were elected to the Executive Committee to succeed the retiring members, T. J. Dolan and S. B. Folk. The Executive Committee is now constituted as follows:

W. B. Johns (Georgia Tech.) term expires 1941
C. M. Olmstead (Univ. of Mich.) term expires 1941
A. S. Adams (Colo. School of Mines) term expires 1942
G. N. Cox (Louisiana State Univ.) term expires 1942
P. G. Laurson (Yale Univ.) term expires 1943
F. G. Switzer (Cornell Univ.) term expires 1943
G. P. Boomsliter (W. Va. Univ.) term expires 1944
E. R. Dawley (Kansas State) term expires 1944

ARTHUR S. ADAMS,
Chairman

Your **Membership Committee** makes the following report for the year of 1939 and 1940:

(1) *New Members.*—The number of the new individual members elected to membership during the past year totaled (379). This represents an increase in individual members for the year of (12½ per cent) ? which is a good healthy growth in membership.

(2) *Future Membership.*—The recruiting of new members from the regular engineering teaching staffs of the various colleges is gradually approaching the point of saturation. A number of schools reported that their engineering staffs have a society membership of 100 per cent. There are other schools which will never

reach this goal. These schools have been pretty well combed and the prospect of getting many additional is not very bright. Therefore, it seems that the new additions to the various teaching staffs will constitute the main recruits from the instructor group.

There are two promising groups from which future members may be obtained. These groups are:

(*a*) The most fertile field for new members is in the engineering service departments, such as chemistry, English, mathematics, physics, etc. The instructors handling engineering students in these subjects are becoming more and more engineering conscious and are very much interested in the work sponsored by our Society, and it is believed that such an association would be mutually beneficial.

(*b*) Another field that should not be overlooked is that of the practicing engineer and the man in industry who are interested in engineering education. This association would afford a number of benefits not directly connected with the teaching of engineering.

(3) *Suggestions.*

(*a*) It is suggested that a leaflet containing Society objectives and membership information might be printed and be made available for future membership committees to use in carrying on the membership work. Probably this would be the most convenient and effective way of contacting prospective members included in parts (*a*) and (*b*) above.

(*b*) When future membership committees are appointed, a definite statement should be obtained from each committee man as to his willingness to function.

In bringing this report to a close, I want to take this opportunity to express my personal appreciation to each of the 138 men who constituted this year's membership committee, for their splendid cooperation in carrying on the work of the committee.

JILES W. HANEY,
Chairman

Sections and Branches.—A new Section, to be known as the Southwest Section, is in the process of being formed. It will probably include Texas, Oklahoma, and New Mexico. The University of Oklahoma and New Mexico State College have voted to join with Texas. Oklahoma A. & M. College is giving consideration to joining with Texas, but has not decided upon its action. It is suggested that final action on the organization of the new Southwest Section and the abandonment of the Arkansas-Oklahoma Section be

deferred until a vote is taken by the members of the Society in Oklahoma A. & M., University of New Mexico, New Mexico School of Mines, and New Mexico Normal University. It has been indicated that the University of Arkansas would probably wish to join with the Missouri Section.

Several institutions in other parts of the country have been considering changing their affiliations with Sections, but no definite conclusions have been reached.

Information concerning the constitutional provisions for forming a Branch was furnished to Michigan State College, but the Committee has not been informed that a Branch has been organized.

Some of the Sections have sent copies of their programs to the Chairmen of the other Sections, and these have proved helpful in planning programs. It is suggested that the Secretaries of the Sections and Branches be requested to exchange copies of their programs with all of the other Sections and Branches.

Early last fall the Committee informed the Chairmen of Sections of the action taken by the Executive Committee at the Pennsylvania State College meeting to discontinue the 50 cents per member rebate (when dues were paid before a given time). Protests were received from several Sections. The Texas Section, meeting at El Paso, March 22 and 23, went on record as favoring reducing the dues to $4.50. Theodore H. Morgan, Chairman of the New England Section, suggests that an allotment of 15 cents per member in the area of the Section would be of great benefit.

The meetings of the Sections and Branches are a very important part of the activities of the Society. It is the only direct contact many of our members have with the Society because they are unable to make long journeys to the Annual Meetings. The programs which have been sent to the Committee have indicated papers, round tables and discussions covering a wide range of subjects of interest to engineering teachers. The most notable program was that of the Pacific Southwest Section which held its Eighth Annual Convention at the University of Nevada at Reno, December 28, 29, and 30, 1939.

Respectfully submitted,

M. L. Enger, *Chairman*
P. S. Biegler
Huber O. Croft
H. E. Degler
C. S. Ell
M. I. Evinger
B. R. Van Leer

AIMS AND SCOPE OF ENGINEERING CURRICULA—A ROUND TABLE*

By H. J. GILKEY

Iowa State College, Leader

At a conference session last Monday afternoon Professor Mockmore told of the contractor, invited to address his students on engineering construction, who started out by urging them to take in college all of the English and public speaking they could get, for said he: "Sometime you will need to tell a city council to 'Go to Hell' and you will want to do it in a nice way."

What better epitomizes the objectives of this session; of this organization; of our very professional existences? While I trust that no undue proportion of our effort is devoted to directing persons or organizations to their appropriate ultimate destinations, we are (are we not?) trying to make engineers who are ever bigger and broader and more competent than engineers have been before. We want them to do things; engineering things (and perhaps a myriad of other things) "in an ever nicer and nicer way."

Other persons and groups tell us that we do do our engineering things in a nice way (I'm not so sure of that, but let it pass); but how about the other things? Yes, we do lack the cultivated mannerisms of the doctor (we're crude), we lack the glib fluency of the lawyer (we're tongue-tied), we won't compromise like the politician (we're inflexible), our surveys are more likely to be topographic than pedagogic (we train but don't educate), we recreate in our labors and would rather build than bull-fest (we're unsocial and have no sense of human values). Others tell us these things, we admit them, and tell them in turn to one another. We have indeed striven to do things in a nicer and nicer way. When in the history of the world has a professional group been more self-condemning; where has a group strained more earnestly from within to attain a many-sided perfection for its successors than have the engineering educators with their Mann Report, the Wickenden Investigation, the E. C. P. D., and the work of this committee? May the time never come when we are satisfied; that would lead to snobbery and stagnation. On the other hand, I frequently wonder if we are really as sick as even we ourselves are so ready to be-

* 4th general session, S. P. E. E., 48th annual meeting, University of California, June 24–28, 1940.

lieve and if we may not at times be a bit too eager to try a pill from every other man's bottle. However, my present rôle is not that of diagnostician or doctor, although just what it is might be difficult to define.

On opposite coasts there have been in session this week two conventions. I shall refrain from attempting to predict which may prove to be of the greater ultimate significance. We are meeting this morning, however, to discuss what may aptly be termed: "A Platform of Engineering Education." The term "platform" is more than just chronologically apt. A platform must above all be large enough to accommodate without crowding a great variety of beliefs. No one man of any party has ever yet been able to keep a foot on every plank of any political platform. Likewise I believe that I am not misstating when I say that the engineering college which adopts this platform in its entirety will indeed be one of many legs and great dexterity.

This conviction is strengthened as I recall the brilliant but diverse utterances of Dr. Steinman on Tuesday, Dean Morris yesterday, and the two major addresses by President Sieg and Dean Derleth at the annual dinner last evening. I know that within the membership of the committee that drafted this "platform" of ours, there exists essentially the same wide range of educational belief and outlook. I predict that the discussions of this session, especially the spontaneous ones that come from the floor, will show a similar diversity.

To me these all indicate clearly and definitely that engineering education is still extremely mobile; that it must for some time to come continue its study and self-searching from within. Any mold in which it is to be cast must be large and it must be flexible. This report is intended to be such a mold; it has a Mother Hubbard rather than a bathing beauty fit.

I suspect that most of those who find themselves dissatisfied with it (if any such there be) will feel tempted to throw the report overboard, not because it fails to include their own tenets but rather because of the extras they find therein. For these persons I entertain a great tolerance; one that amounts to a bond of fellowship for it was in exactly that situation that I found myself last winter when it came time for the members of the committee to place themselves individually on record with respect to this document. True, it represents the work of all but nevertheless in its detailed contents it is probably not as any single member of the committee would prefer to have it.

At the risk of being a bore, I am going to recite some of the reasons for casting my ballot in favor of the report in spite of

strong doubts then and now about the workability of some of its clauses. This recital is forced upon you solely with the thought that some of you may be moved to view more tolerantly than otherwise such of its recommendations as seem to be just a bit too large for your throats. The following comments were formulated about the middle of last December which may account in part for their biblical yule-tide cast.

"From the miscellany of comments (received on the report) it is apparent that this report rivals the Bible in its ability to be all things to all men. To some it is the word of the prophet, a definite guiding star; to others it is the babel of many prophets, a galaxy of stars.

"To those already committed to a philosophy of engineering education the report is apparently proving to be a source of satisfaction, comfort and guidance. Each individual (or institution) can face in any desired direction and, lifting his eyes unto the heavens, he will there discern a bright star guaranteed to direct him toward the manger of his choice.

"Those who are satisfied with their present programs can read into those portions of the report which they choose not to ignore, full justification for what they are doing. Those who are dissatisfied will find plenty of support for each desired change. For those institutions which find laboratories and technical instruction costly, the emphasis upon the 'broad fundamentals' and 'less undergraduate specialization' will be soothing alike to the comptroller and to the administrator's conscience. If we take the report as literally, as some might, we find that the retention of the four-year undergraduate curriculum is recommended in words. The extension of the period is no less definitely stipulated by the content.

"The diversity of comment from without is quite in accord with the diversity of educational philosophy represented within the committee. It seems to be quite clearly demonstrated that engineering education is not ready to be cast in any general mold but that a period of experimentation lies before us during which the Luther Burbanks of this educational age are destined to practice their arts upon the *two* (or more) *stems* of our educational plants to see whether they evolve into a banyan-tree forest or become perhaps a forest of stemless wonders, thriving without a visible linkage to the earthiness of reality.

"While the answer cannot be immediately forthcoming, not many years can elapse until the success or failure of efforts at pioneering by individual schools will be amply reflected by their enrollments and in their placements. Perhaps such criteria are not fair, but they are potent. Regardless of the origin of the ques-

tion, the validity of the answer is determined, rightly or wrongly, by the related economic factors involved.

"In view of the foregoing aspects and considerations, I desire to record myself as being heartily in favor of this report, essentially as it is, not because I agree with all that it contains or with the conclusions offered, but rather because of:

1. Its great value as a document which sets forth the organization and current problems of engineering education and the diverse aspirations of engineering educators.

2. The definiteness with which it demonstrates that engineering educators are not now sufficiently of one mind to agree upon a common curricular pattern, however general, but that nevertheless any program adopted should be of the integrated rather than of the stratified variety.*

3. Its all-inclusiveness and inconclusiveness; its inherent contradictions, which in provoking criticisms from many quarters will stimulate thought and may usher in an era of educational experimentation, confusing for the present perhaps, but charged with possibilities for great ultimate betterment.

"This is endorsed, therefore, not as the *last word* but rather as a highly significant *first word* that may be provocative of others."

I believe that, like the Bible, this report can be made to serve as a nucleus for a variety of curricular patterns from the functioning of which we can gain a factual basis for continued progress and evolution.

The primary objective in planning this session was to get the report of the S. P. E. E. Committee on "Aims and Scope of Engineering Curricula" before you for question, analysis and criticism. The method selected should be reasonably apparent from the printed program. Following the more or less formal scheduled presentations, the period of questions from around the table is in part, at least, to bring out points that some of those on the platform may feel to have been omitted or inadequately covered. The third stage, the questions from the floor, is intended and expected to produce the fireworks; that is the "safety valve" portion, "democracy in action."

The scheduled program has been changed a bit because Dean Hammond was unfortunately called home yesterday. I am sure that I speak the thoughts of every man on this committee when I express my admiration almost to wonderment for the manner in which Dean Hammond maneuvered this unwieldy bunch of educational individualists, not only keeping them hitched, but holding

* Meaning that non-engineering subjects and sequences should not be segregated to either a pre-engineering or post-engineering period but should be carried along as a planned, integral portion of the engineering curriculum.

them to the furrow, with fairness, firmness, and inexhaustible patience. I know that Dean Hammond had taken this assignment, as he takes all assignments, seriously and that he was prepared to give us certain needed angles that are inherently tied up in him. His absence is a loss.

Probably no member of the committee labored harder than did President Doherty and in the absence of Dean Hammond, probably no man is better qualified to discuss the report and its background. This President Doherty will do as an added assignment in conjunction with his own scheduled presentation.

SOCIAL-HUMANISTIC ASPECTS OF THE CURRICULUM

By R. E. DOHERTY

President, Carnegie Institute of Technology

I am very sorry indeed that Dean Hammond was called away, because he has handled this problem and had the responsibilities of Chairmanship on his shoulders and has, therefore, a view of a whole to a much greater extent than any of us who were individually pressing our own views in the committee.

I cannot summarize or give the background of this report, I suspect, without having it colored a little bit by my own opinions, but I shall do the best I can.

Anyone who watched Dean Hammond in his work with this committee must have had, as I had, high respect for his leadership, for his patience in trying to compromise points of view—for I can assure you there were widely divergent views represented on the committee—and I wish to state my high esteem for his leadership in this work and for the contribution which he made to it.

There were certain pressures that led up to the committee's study. One was that the thoughtful public, realizing the technological nature of our civilization, has demanded that engineers understand the social problems they create. Then, the engineers themselves have made certain demands. Some of them have demanded one thing, and others have demanded others. You all heard Mr. Steinman's presentation at the meeting on the first day, I believe. The group that he represents demands a clearer definition of professional status, higher qualifying standards, and exclusive attention to professional engineering education. Then there are others, probably a majority of us, who wish to see not only the things that Mr. Steinman and his colleagues would like, but also recognition of the engineers' functions, both technical and administrative, in industry and public service.

Also there is a pressure from the people interested in general education, not engineering education only, but education in general. They press for the support of the movement to extend general education beyond secondary schools and to postpone specialization for, perhaps, at least two years beyond secondary schools. The junior college movement is one phase of this.

Then, the rapid and continuing advance of science and the swift changes in technology press for recognition in the curriculum. I don't have to amplify that point to this audience. This pressure leads to emphasis on particular items of knowledge at the expense of fundamental relationships.

Now, of course, there are other pressures, as I have chosen to call them, but these are the primary ones which led, I think, to this committee's study. It was precipitated, as you may all know, by the act which was introduced in the New York Legislature by the group which Mr. Steinman represents. That act would require two years of pre-engineering training in a liberal arts program. But that move merely precipitated action by the Society; the pressures already existed and action was impending. In other words, these other pressures had brought the people interested in engineering education to a point where they were ready to undertake a revaluation of the purposes of engineering education.

The first step in the study was an attempt to determine and set down the important facts in the situation—the situation out of which grew these pressures.

What were the facts?

One was the diversity of organizations that offer courses in engineering: complex universities, privately endowed technological institutions, colleges in which programs in engineering are alongside those in liberal arts; and the junior college movement. All of these represent a great diversity in the organization of engineering education.

In spite of this diversity of organization, however, there is a common denominator that runs through all, and it is the engineering method. I think this is, perhaps, the most important fact of all: that regardless of what organization gives the instruction there is at the bottom of it all the cultivation of the engineering method.

Another fact is the diversity of function which the engineering graduates undertake after they leave college. I don't need to outline these to this audience, but the fact is that there is a diversity of function; they do all manner of things.

Another related fact is that there is no sharply defined boundary of the engineering profession. It is merely one part of a

much broader field of activity for which engineering education is effective as a preparation.

Unlike law and medicine, which are fairly closely knit professions, engineering has a central core of specialized technical and professional activity, but around this is a fringe or an area that represents service in industry and public service that requires the type of mind that an engineering college cultivates, and there is no definite line that you can draw around that central core of professional service. So it is unlike law and medicine in these respects and anybody who doesn't understand that decisive, fundamental fact does not understand the problem of engineering education.

And finally, engineering education is influenced by professional societies, by licensing boards, and by industrial interests.

Now, these are the facts in the situation that gave rise to the pressures I indicated at the outset, and with these in mind the committee undertook to state its problem.

The first item of the statement of the problem was to formulate a philosophy of engineering education: to state the general purpose, to define the scope of the world which engineering education professes to serve; whether, for instance, it will serve the area that Mr. Steinman referred to, or whether in addition it would include the wider field of industrial management and public service, or still further, to include the training of men for supervising all aspects of industrial operations, and also whether or not engineering education should regard competency of citizenship as one of its responsibilities.

The second item in the statement, as I have understood them, is that the committee should attempt to specify competencies which the student should have at graduation that are requisite to the undertaking of such services.

Having specified these—the statement of general purpose and the competencies which students should achieve before graduation—it then becomes possible, and it is not possible in my opinion before that time, to draw some rational inferences as to the specific character of programs, and as to the length of time required to complete them.

As to general purpose the committee believes, if I have understood the conclusions correctly, that engineering colleges should serve the technological world, not merely in those areas of highly specialized professional engineering, but also in those areas of industrial activity and public service where the engineering method strengthens leadership; and engineering colleges should also regard competent citizenship as one of their responsibilities. On the other hand they should not undertake, as they now do to too great an

extent, the training of skilled technicians. This task should be the responsibility of technical institutes.

Under such a general purpose and in view of the facts of the situation as it currently exists, the Committee concluded that there should be cultivated in college two stems of educational growth that would continue after graduation. It has attempted to name these stems and to specify them in terms of competencies. The one stem was named the scientific-technological (that is a jaw-breaker, but it is descriptive, I think, of the purpose involved), and the other the humanistic-social.

I would like to emphasize that the committee feels, and I think on this point it is almost unanimous, that these stems should represent programs, articulated sequences of studies, and not miscellaneous electives.

I wish to say a parenthetical word regarding the design of an educational program. There are two methods of approach. One is the usual procedure of listing what appear to be appropriate subject matters in what also appear to be appropriate quantities of semester hours. I think it is fair to say that the basis for the selection of subject matters and semester hours has been largely "that the student will need it all after graduation," and partly, at least, that other institutions have on the average made such selection. The process is not unlike specifying, in the design of a transportation vehicle, the structure, materials of construction, and the time schedule, without knowing the destination and without adequate consideration to the service requirements to which the vehicle is to be subjected.

The other method is the engineering method, namely, (1) to settle upon, as far as may be possible, the general fields in which engineering graduates are to serve; (2) define the primary competencies that are requisite to service in those fields; (3) design a program that will cultivate those competencies.

Your Committee has recommended the latter method and has attempted to carry out the first two steps specified therein. It naturally leaves to individual institutions the execution of the third step which involves judgment as to ways and means. And to execute this third step is the responsibility of any institution that cares to follow the recommendations of the Committee.

I would now refer specifically to the humanistic-social stem—Mr. Wessman, I understand, will later outline the scientific-technological aspects of the proposed program. The humanistic-social studies should, in the opinion of the committee, be directed toward these six items of competency on the part of the student at graduation, not at the end of his sophomore year to be forgotten, or at the

end of his junior year to be forgotten, but competencies he should have when he graduates:

1. An understanding of the evolution of the social organization within which we live, and an understanding of the influence of science and engineering on its development.
2. The ability to recognize and to make a critical analysis of a problem involving social and economic elements to arrive at an intelligent opinion about it and to read with discrimination and purpose toward these ends.
3. The ability to organize thoughts logically and to express them lucidly and convincingly in oral and written English.
4. An acquaintance with some of the master pieces of literature and an understanding of their setting and influence upon civilization.
5. Development of moral, ethical and social concepts essential to a satisfying personal philosophy, to a career consistent with public welfare, and to a sound professional attitude.
6. The attainment of an interest and pleasure in these pursuits and thus an inspiration to continue to study them.

Now, of course, there are numerous ways, numerous plans of courses, which would accomplish these ends; and undoubtedly when and if educational institutions undertake to incorporate these purposes in their programs the result will be widely different plans and procedure, but that doesn't matter. The thing that matters is a recognition of the purpose and an attempt to achieve the purpose through whatever means seems to be wisest in the particular situation.

Now, there are certain general conclusions. What changes do these recommendations imply in the curricula as they now stand? What are the demands of specialized engineering activity and how are they to be met in the picture? What about the length of curriculum, and who shall determine the content?

Well, the implied changes might be summed up in this way: That it is the opinion of the committee that more attention should be given than now to the cultivation of these competencies indicated in the humanistic social stem; and that also the scientific side of the engineering curriculum should be made more basic and less specialized. It is the hope that the reduction in the specialized and advanced content of courses and the postponement of much of this to postgraduate years will make available additional time in which to develop this humanistic-social stem.

But what is much more important than the time devoted to this matter is recognition of the basic proposal that there should be a unified sequence of study, a purposeful program.

The purposes—I think the committee would agree on this point—the purposes set out in the humanistic-social stem are not to be achieved by a miscellaneous group of elective courses in this and that. Even if you took 50 per cent of the time it is my personal opinion that they could not be achieved because pursuing such courses doesn't cultivate most of the abilities referred to.

It is the hope that in such an undergraduate program as that recommended a basis would have been achieved by the student at graduation that would make it possible for him to do either one of two things: If he wanted to go on to the higher scientific levels of engineering and specialize in professional engineering he could either continue in postgraduate work, or if he didn't go into postgraduate work he might go into industry and study there; in any event, continued study based on the foundation laid in his undergraduate work.

On the other hand, if he wanted to go into other services in industry and public service, but not in the professional and specialized engineering, the 4-year program would give him the basis for such a pursuit.

So the committee concludes that a 4-year program is not adequate to cover the ground that is necessary for professional engineering on a high scientific level. It should be supplemented by additional work either in graduate courses or in informal study later in industry. But the 4-year program is adequate for other pursuits.

Another conclusion, as I have already intimated, is that the technical institute should be encouraged and thus relieve the engineering colleges of the burden they now have of carrying many boys who should be in technical institutes and should not be undertaking work of advanced quality.

Another conclusion is that no measures, either legal or in plans of accreditation, should limit the freedom of experimentation and change which we now have in our colleges. Whatever else happens engineering colleges should retain that freedom and not be hamstrung by laws and by accrediting bodies that specify requirements that limit and ruin the freedom of experimentation.

Now, are these programs practicable to carry through?

As the Chairman indicated, time only will tell, but there are a few institutions which have undertaken to formulate programs that would recognize the recommended objectives. I know of at least three.

One is Dean Hammond's college, Pennsylvania State. They have undertaken the study and formulation of new programs which, in their opinion, conform to the general purposes outlined in this report.

Another is Cooper Union. Any of you who saw the May issue of the JOURNAL OF ENGINEERING EDUCATION, will have read there Professor Lynch's description of Cooper Union's attempt to incorporate in their work the humanistic-social stem as outlined here.

Also the institution, which I have the honor to be associated with, has inaugurated a new program devoted to the aims recommended by the Committee.

A DETACHED CRITICAL ANALYSIS OF THE REPORT ON AIMS AND SCOPE OF ENGINEERING CURRICULA

BY FRANKLIN THOMAS

Professor of Civil Engineering, California Institute of Technology

The "criticism" which results in this instance from several readings of this report is almost entirely in the form of commendation and statement of satisfaction. The speaker undertook to offer some suggestions for changes based upon the preliminary draft of last November. However, before those suggestions reached the Committee, numerous revisions of arrangement and language had already been made which rendered the suggestions no longer pertinent. Naturally then, from the speaker's viewpoint, the report had been materially improved and it is with the report as published that we are to deal today.

Appreciation should be voiced of the admirable manner in which the content of the report is organized and expressed.

The objective of this committee in formulating a representative and authoritative statement of aims and scope of engineering curricula is very timely and an identification and statement of aims should have a distinctly constructive influence upon engineering education in this country.

The statement of Current Problems, which recognizes the appearance of new knowledge and fields of application, cites the reasons for inventories and valuations of present-day engineering curricula. Each of the last four decades, during which engineering education has experienced its great development, has produced marked changes in the nature and direction of engineering activity where graduates of colleges are absorbed. In the face of such far-reaching changes, curricula cannot remain static. During these decades, when the direction in which engineering activities has shifted so drastically, conditions have developed in a way which makes more vital than ever a thorough training in the fundamentals which underlie the applied engineering subjects; while at the same time, new forms of application of engineering science have

been pressing for attention in the already well-filled engineering curricula. Displacements have been necessary, as witness the reduction in the time devoted to surveying, perspective drawing and stereometry, railroad engineering, shop work, voluminous descriptive courses, and other types of subjects representative of technique or practise. While these transitions were being effected, the increased insistence that engineering students be given more training in English and other humanities came, oddly enough, from employers with the result that there has been a marked response made by the engineering colleges to this recognition of engineers' needs.

It is not surprising that proposals for elongation of the engineering training beyond the conventional four years should have arisen as a means of relieving the congestion of curricula. On the other hand, there is much advantage in adhering to the four year period. With the fundamental scientific subjects and the properly condensed scope of applied engineering subjects taken in conjunction with a reasonable amount of the humanities, a very satisfactory undergraduate program, leading to the baccalaureate degree, may be arranged.

In order to achieve such a curriculum both thorough in character and broad in scope, the engineering applications must be limited quite definitely to those of an analytical character, and unquestionably such a program of study could not readily be surpassed in its effectiveness as a medium for training students to think. It is not educationally feasible or physically possible to crowd into four years all of the engineering applications which are of vital significance at the present time, so there is no alternative except the devotion of additional time on the part of the individuals who possess the superior qualifications and the interest for more intensive preparation for an engineering career.

All things considered, I am very much impressed that the conclusion of the Committee is unquestionably correct that the manner in which the urgent needs which confront engineering education can most satisfactorily be met is by providing opportunity for the selected few to devote more time to the superstructure, rather than by requiring all engineering students to devote more time merely to laying the foundation upon which many students never would build an engineering career. By retaining the four year engineering program somewhat broadened in character and by providing means of extending the preparation of the qualified few by graduate work, the welfare of the individual students can best be promoted and the needs of the engineering profession best be satisfied.

The history of experiments in engineering education demonstrates that the boy who is inclined toward engineering education wants motivation in his program. A preëngineering liberal arts

course fails to provide this motivation and has been conspicuously unsuccessful where tried.

About twelve years ago, the curriculum in engineering at an institution with which I am familiar was revised so that it has a striking conformity with the principles as expressed in the following paragraph under "*General Policy*" of the Committee Report:

> Preparation for the higher technical levels of engineering is unquestionably a duty of the engineering colleges. Such preparation clearly requires more than a four-year period and should extend beyond the baccalaureate degree. Provision for postgraduate education is necessary, furthermore, if adequate time is to be allowed in the undergraduate period for thorough grounding in the basic sciences, for laying the foundations of a social philosophy, for developing powers of effective expression, and for cultivating reflective and critical habits of thought. If the undergraduate period is concentrated chiefly on these objectives, and if, at the same time, an adequate introduction is given to engineering methods of applying science to actual problems, the value of the four-year program, we believe, will be enhanced. To attain these objectives will require the transfer of some of the more advanced subject matter to the postbaccalaureate period where it may be pursued with a rigor consistent with adequate preparation for engineering specialization.

In this particular curriculum to which reference has been made, provision was made for thorough training in the fundamental subjects such as mathematics, physics, and chemistry. Provision also was made for approximately 25 per cent of the time in the four undergraduate years to be devoted to the humanities. The engineering applications of an analytical character were given an adequate allotment of time, but the time devoted to descriptive subjects was compressed to the bare minimum. It was not possible to introduce all of the technical applications which justifiably could be included in an engineering curriculum, but provision was made for an intensive fifth year leading to a Master's degree. Such a revised curriculum cannot devote time for work which belongs with the secondary schools. Selectivity is accomplished through admission examinations. Freshman mathematics begins with analytic geometry. The study of physics extends through the first and second years. Mechanics and hydraulics are reinforced by the use of weekly computation periods. In the operation of this plan it has been found that most students reach their academic ceiling with the attainment of the baccalaureate degree. Men in the upper third of the senior class, seem to be qualified when they attempt the work leading to the Master's degree. Occasionally men of superior qualifications, generally without any encouragement from the faculty, undertake the additional study leading to the Doctor's degree.

The experience with such a plan has been gratifying. Men who go into engineering positions upon completion of the four years appear to be readily adaptable to the diversity of positions into which they go, in spite of the somewhat restricted phases of their training in respect to engineering subjects. The men who have returned for the Master's degree, which usually is attained by one year of graduate work, and the men who have come from other institutions after having completed their undergraduate work, have generally demonstrated that the investment of the additional time and money has produced satisfactory return as the result of their improved qualifications and extended training.

The report represents an accurate diagnosis of present conditions affecting engineering education and presents sound conclusions which if put into effect would bring engineering education in line with the needs of engineering practise and the current aims for professional improvement. The conclusions are such that they may be adopted easily with a minimum of disturbance in and departure from present educational activities in engineering colleges.

TECHNICAL ASPECTS OF THE CURRICULUM

By HAROLD E. WESSMAN

Chairman Dept. of Civil Engineering, New York University

Engineering education has always been confronted by new discoveries in science and by changes in technology. In recent years, the tempo of this constant advance has been accelerated. The accompanying problem of adapting engineering curricula is consequently becoming more complex, not merely because of the volume of new knowledge, but primarily because it is difficult to insolate that which is *fundamental* from that which may be termed *"specialized application."*

Part of the recommendations of the Committee on Aims and Scope of Engineering Curricula may be briefly phrased as follows: Four-year undergraduate curricula should incorporate *fundamental* scientific and technical content, whereas advanced technical subject matter should be offered in the postgraduate period.

My assignment is to discuss The Status and Trend of the Technical Aspects of Engineering Curricula. One can learn something about Status by scanning college catalogues and reading course descriptions. It is not an easy matter to discover trends, however, without the benefit of personal observations from many who are closely connected with functioning of departmental curricula. Hence, I prepared a short letter with 5 questions, and sent it to

about 100 engineering teachers, most of whom are heads of departments of civil, electrical, mechanical, and chemical engineering. The response was fine. Many availed themselves of the opportunity to express their views in detail about engineering education. I wish I could quote some of them, but there is only time here to voice my appreciation to all who answered my letter.

The first question was as follows: "Is there a tendency to pack more specialized technical content into your undergraduate curriculum?" 25 men answered, "Yes." 52 men answered, "No." The second question was, "Is there a tendency to eliminate senior options?" This referred to options such as Communications or Illumination in Electrical Engineering, Power in Mechanical Engineering, or Sanitary or Structural in Civil Engineering. The answer was overwhelmingly, "No." One school, however, with a large number of options is planning a reduction.

Curiously enough, a number of department heads answered the first question in the negative, but then, in answer to the second, stated that they had recently added technical options. In such cases, the answers seemed somewhat inconsistent, because if optional groups of specialized courses are being added, there certainly is a tendency to increase technical content in the undergraduate program even though the total number of required hours may not be changed. When more technical options are made available, it is doubtful if students will select alternative non-technical courses.

A number of responses to the first two questions indicated that there was considerable pressure from industry and practicing engineers to increase special technical content. Chemical engineers and electrical engineers in particular emphasized this problem, although it is not one which they alone have to face.

It is worth noting here that the options in Mechanical Engineering most often encountered are termed "Power" or "Technical Option," "Industrial Option," and "Heating and Ventilating Option." Some schools have many more. In one case, there were ten options. Others have none whatever. Options most often encountered in Electrical Engineering are the "Power Option," "Communications Option," and the "Illuminating Option." In Civil Engineering, the three options generally encountered are the "Structural Option," the "Highway Option," and the "Sanitary Option." Again, some schools will have none at all, whereas others will have more.

The third question was this: "Is there a tendency to make more non-technical electives available, particularly in the junior and senior years?" It is not within my province to discuss this matter, but 52 said "Yes," 26 said "No." Many stated, however, that students will not take these non-technical electives. I should

have asked whether a mandatory integrated program was planned. I am sorry I failed to do this in my questionnaire.

The fourth question was this: "Is there a tendency for young instructors to incorporate advanced technical content in undergraduate courses, content which essentially belongs in graduate courses?" This question was asked because the tendency had been encountered in my own institution. Also, in listening to S. P. E. E. group discussions during past years, it seemed to me that a number of schools were definitely incorporating graduate content in undergraduate work. 48 said "Yes," 27 said "No." A number of those who answered "Yes" stated that older instructors were at fault in this matter just as much as young instructors. A number of men, particularly in electrical engineering and chemical engineering, were very emphatic in their response to this question, stating that younger instructors often upset fundamental courses and had to be watched constantly. Young instructors came to them with advanced degrees and the natural tendency was to take the training which they had received in their graduate study and incorporate it into the elementary undergraduate courses.

This tendency has also been fostered somewhat in schools where little graduate work is available. It is only natural that some teachers desire to give their better seniors a little more training in advanced fields, because of the belief that most of these students will not enroll in advanced study.

In answer to this question about the incorporation of advanced technical content in basic undergraduate courses a number of men in electrical engineering pointed out that discoveries in modern physics resulting in new machines and applications have transformed what was formerly graduate content into fundamental undergraduate content, and that undergraduate courses were being constantly revised in the light of the discovery of new fundamentals. I am inclined to believe that electrical engineering is quite different from civil engineering in this respect. Fundamental undergraduate content in civil engineering has changed relatively little in the past 15 years. Specialized graduate content, on the other hand, has changed a great deal. There is, however, altogether too much tendency to incorporate advanced structural analysis, developments in photo-elasticity, soil mechanics, and fluid mechanics into undergraduate civil engineering courses.

The fifth and last question asked was this: "Is there any tendency to decrease the total credit hours required for graduation?" This likewise is not within my province to discuss at this time. The answer was overwhelmingly "No." In fact, the number of schools still requiring more than 144 credit hours for graduation is unusually large.

I am not attempting to write specifications for the scientific-technological stem, but I hope that this brief presentation will indicate the trends in the technical phases of engineering education, even though the picture is not clearly defined. The majority of schools are not increasing technical content in undergraduate curricula; but as yet there is no pronounced tendency to reduce the number of optional groups. On the other hand, more studies in the social sciences and humanities are being made available. I sincerely believe that many institutions need to make a thorough study of their various curricula in the light of the report on Aims and Scope, whether they agree with it or not. An increased emphasis on graduate study may be a desirable result.

The war in Europe has focused increasing attention on the part of science and technology in creating instruments of destruction. We must not forget, however, that science and technology are the only means of preservation, of guarding and maintaining the American heritage, even though for the time being the concentration of effort be on purposes too horrible to contemplate. And, in discussing engineering education, we must not for a moment forget that science and technology constitute the dominant interest.

But, to guard against the continued prostitution of scientific purposes, it is even more important now that an intellectual and moral interest in social and human relations be awakened and nourished in the training of future engineers, difficult though this may be. On the walls of the Stanford church which we visited on Wednesday, there is cut in stone this message for all of us:

> No widening of science, no possession of abstract truth, can indemnify for an enfeebled hold on the highest and central truths of humanity.

INTEGRATED VS. STRATIFIED CURRICULUM

By EDWARD L. MORELAND

Massachusetts Institute of Technology

The "Humanistic-Social" content of engineering curricula varies within fairly wide ranges, but practice seems to indicate that in an ordinary 4-year course in engineering instruction about one-sixth to one-fifth of the student's time can well be devoted to subjects in this category. The question arises whether these subjects should continue throughout all four years, or whether there may be advantages in stratifying them by placing them exclusively in a certain part of the whole 4-year program.

Theoretically, a stratified curriculum could be set up in which the essential Humanistic studies would all come at the close, or near

the close, of a student's 4-year program. Practically, however, it is at once obvious that any such plan would break down, for two reasons:

1. Many essential Humanistic-Social studies, notably English Composition, Elementary Economics and, in some cases, a reading knowledge of a modern foreign language as well (if the latter is to be required at all) are essential and necessary tools to be used in later subjects both professional and non-professional in character.

2. The second difficulty with stratification in later years arises from the natural desire of the student at that stage for more advanced work of a professional character. He simply would not be interested in concentration on non-professional subjects at that time.

If then the stratified plan is to be used the humanistic subjects must, as a practical matter, be placed in the first two years.

At first sight a stratified curriculum of this second type seems alluring because it allows for complete specialization in later years and assumes that the necessary cultural and humanistic courses can be cleared away at an early stage in a student's program.

Practical difficulties again appear with this program. Engineering students must get during their first years those basic elementary college subjects without which advanced engineering subjects are entirely impossible. In most institutions the required freshman subjects include mathematics, chemistry, physics, and engineering drawing—four fairly difficult and absorbing subjects which take at least four-fifths of the student's time in his freshman year, leaving a scant 20 per cent of available hours for English composition in which the work of the high school and the preparatory school has left most students obviously deficient and in need of instruction of a much more advanced character than that given in any but the best preparatory institutions.

Similarly, an examination of sophomore curricula shows almost at once that, while these courses are not quite so crowded, it would be very difficult to find time both for essential elementary subjects of a scientific character and also for more than two other subjects.

It may be noted in this connection, that the difficulty of placing more than three such subjects in the freshman and sophomore curricula would not at all be solved by having a student attend an Arts College before going to the engineering institution, for in either case he would be compelled to take approximately the same subjects which he now pursues if he is to go on with professional work in which he is primarily and properly interested.

Even if it were technically possible to crowd all the subjects of a humanistic-social character essential for a sound general edu-

cation and consistent with sound professional training into two years, it may well be doubted whether the educational results would be desirable. For students primarily interested in pure and applied science, any more time devoted to these subjects in the first two years would undoubtedly frequently be distasteful. Further the student would inevitably gain the impression that these were chores to be performed, which had no essential relation to other more important subjects which he was pursuing, and which once performed could be put entirely out of mind as having no further value. One of the common difficulties is that students are likely to put their humanistic-social subjects into water-tight mental compartments entirely shut off from their professional work. Concentration of all the humanistic-social subjects in the first two years would greatly increase this tendency.

At the same time, the humanistic subjects would lose the advantage of continuity in which progress is made from elementary subjects to those somewhat more advanced. No matter how many subjects in English, language, history, philosophy, or economics can be crowded into early years, every individual subject, and indeed the whole program, continues under such a plan to be necessarily elementary. An advanced subject requires previous thought and training; and this is just as true in the humanities as it is in science. Subjects which a student can well understand and appreciate when he is 20 years old are often without significance or meaning when he is 17. The stratified curriculum abandons progressive advancement in maturity and skill.

Psychologically also the stratified curriculum overlooks the law of habit by which any skill or aptitude is perfected by repetition and is only fixed when time enough has been given not merely in quantity but in duration to establish interests and to fix capacities.

For these reasons, and for others, of a similar character which might be cited, it seems to me that an engineering curriculum which combines careful technical training with a sound general education should include a limited but continuous and well integrated program of studies in which—not in his first year nor in any single year thereafter—but throughout a well planned curriculum of four years a student first acquires certain skills, develops certain interests, and then finds these skills and interests growing by the additional uses to which he puts them in the concluding years of his course. All this I believe can be done without seriously encroaching on the time devoted to professional subjects by developing as careful coördination of the humanistic courses as is now to be found in the fields of pure and applied science.

Briefly, the question is whether we shall drive our horses abreast or tandem. In the case of the humanities the rules are exactly the

same as those which favor the latter alternative in all other fields of education.

As a concrete example, I am suggesting a possible program in the general field of the humanities in which an effort has been made to secure continuity and coördination:

SUGGESTED EXAMPLE

Subject	Year	1st Term	2nd Term	Total
English.....	1	3—5*	3—5	16
Language or Economics.....	2	3—3	3—3	12
English.....	2	3—5	3—5	16
Economics or † General Study..	3	3—3	3—3	12
† General Study....	4	3—3	3—3	12
				68

* 3—5 indicates 3 class hours and 5 hours of preparation.
† Selected to provide a coördinated program in the humanistic-social stem.

In this program, as will be seen, a student has at least one subject outside his immediate profession in every year, with a maximum of two in the sophomore year when he has already completed his elementary sciences and has not yet commenced advanced courses in engineering. The single subject of the junior year should not only introduce the student to new ideas, but should carry on the English training of the first two years. So far as possible, in both of the last two years practical use should also be made of the reading knowledge of any foreign language which may have been acquired earlier.

The subjects in the junior year might well be concrete and factual; and in the senior year the student would then be sufficiently mature and well trained to take a single subject which gives him a wider theoretical conception of all the studies in the humanities or the social sciences which he has previously pursued.

By an integrated program of this kind, as the professional subjects become more detailed and technical, the non-professional subjects become, conversely, more philosophical. The result might well be a more balanced and well-rounded education which, without sacrificing accuracy or technical efficiency, never loses sight of the essential unity of all the disciplines, scientific, humanistic, and social.

ARE RECOMMENDATIONS OF THIS REPORT COMPATIBLE WITH A FOUR-YEAR CURRICULUM

By IVAN C. CRAWFORD

University of Michigan

This subject might indicate to some that there is grave doubt as to the possibility of carrying out the recommendations of the Committee within a four-year engineering curriculum. When the matter was under discussion in the Committee it was felt that, quoting the report, "*some* of the advanced technical subject matter now included in undergraduate curricula should be transferred to the post-graduate period where it might be pursued with a rigor consistent with preparation for engineering specialization." Of course, the word "some" is quite indefinite. After having defined "advanced technical subject matter" we shall be in a better position to determine the amount, if any, to be transferred to the post-graduate period. This amount will vary with every curriculum and with every engineering school throughout the United States.

Perhaps a better way of approaching the subject would be to set a minimum number of hours to be devoted to humanistic and social subjects during the course of the four-year engineering curriculum. Considering freshman composition to be a humanistic subject, and also that speech and advanced composition fall within such a classification, let us assume that the humanistic-social requirements may be met by reserving a three-hour course in each semester throughout the four years for such studies. We should then have twenty-four semester-hours devoted to social and humanistic courses, or somewhere between two-thirds and three-fourths of a year's work.

At present, how many schools have twenty-four semester-hours in a four-year curriculum which is or can be devoted to such work? An examination of engineering curricula offered by fifty-four recognized engineering schools scattered throughout continental United States uncovered the following data: 1, in each of twenty-nine schools two or more curricula now have twenty-four semester-hours which are devoted to English composition, speech, English literature, economics, and free electives; 2, ten schools of engineering have two or more curricula in which twenty-one semester-hours are devoted to the subjects enumerated above, and 3, six schools fell below twenty-one semester-hours.

If the minimum time requirement for the humanistic-social studies be set at twenty-four semester-hours, the recommendations of this report are compatible with a four-year curriculum inasmuch as twenty-nine schools of the country are operated at present on a

basis which affords that much time outside of the technical and scientific time requirement of the curricula. Neither is there any doubt but that with a very little adjusting ten more of the schools would be able to conform. Fifty-four per cent of the schools considered are now in a position to adopt the Committee's recommendations or have anticipated these recommendations. Seventy-four per cent could be placed on that basis by making relatively minor adjustments.

The recommendations of this report are compatible with a four-year curriculum.

A PLEA FOR A LIBERAL FOUR-YEAR ENGINEERING CURRICULUM

By PAUL T. NORTON, JR.

Professor of Industrial Engineering, Virginia Polytechnic Institute

The 1940 Membership List of the American Society of Mechanical Engineers contains a Professional Service Index of about 700 A. S. M. E. members engaged in independent consulting practice. This list was compiled from special reply cards sent to all members of the Society at the time information was sought for other parts of the membership list. There are, of course, many other members of the society whose work is confined almost entirely to the technical phases of engineering; but the fact that only about five per cent of the more than 14,000 members of the A. S. M. E. are engaged in independent consulting practice seems significant. Other available information indicates quite conclusively that only a small percentage of engineering graduates become independent consultants, which seems to be the most fundamental difference between the profession of engineering and the professions of law and medicine.

In the December, 1939, issue of the JOURNAL, Dr. D. B. Steinman asked for an engineering profession of planners and leaders and not of mere technicians, and also stated that we need education and not mere technical training. All of us will agree with these statements, but most of us apparently do not agree that the best way to improve our present procedure is to have two years of study in a liberal arts college before enrolling in an engineering college.

It may be true that six years of college training is very desirable for a man who is to become an independent consulting engineer, and who presumably needs not only a liberal education and the basic fundamentals of engineering, but in addition much specialized training in his particular field. If that be the case, the man who

intends to become an independent consultant should expect to devote six years to his formal college training. But a majority of our engineering graduates, and many of the most able of them at that, never become independent consultants, but instead go into industry upon graduation, where they must serve a rather long apprenticeship. These men need both the liberal education and the fundamentals of engineering, but they most certainly do not need the specialized training of the independent consultant. For most of these engineers in industry a liberal four-year undergraduate engineering college training should be adequate as far as their formal college education is concerned.

It would indeed be unfortunate if the extra specialization needed by the independent consultant could not be added to the four-year undergraduate program just mentioned. Luckily there does not seem to be any reason why Dr. Steinman cannot have exactly what he wants during the six years he advocates by merely adding two years of specialization to this four-year program, provided he is willing to spread the courses which he desires for their liberal educational value over the first four years rather than to concentrate them in the first two years. The procedure of spreading these courses over the first four years would seem to have two distinct advantages which Dr. Steinman has apparently overlooked. In the first place, the average student who enters college with the idea of becoming an engineer wants to make at least a start in technical studies as soon as possible and his interest in his work would be greater during these first two critical years if he could see that he was at least beginning the study of what he considers to be engineering. In the second place, maturity is a great advantage in the study of certain of the liberal courses, as those of us who teach what Dr. Wickenden has called "the semi-humanities of business and management" know only too well.

It should be possible to arrange a four-year undergraduate engineering program which will give both a liberal education and also the engineering fundamentals which all engineering graduates simply must have. The men who complete this four-year program would be equipped to enter most of the positions in our various industries for which newly graduated engineers are now employed. Those who, for any reason whatever, desire additional formal education, could take one or more additional years as graduate students. Still another advantage of this procedure may be cited. Few young men know, even at the end of four years of college, whether or not they should attempt to become independent consultants. The four-year program just outlined would permit a young man who has completed the program to get a job in industry and to find from actual experience whether it was best for him to

remain in industry with his four-year preparation or to go back to college for additional studies.

The speaker agrees with Dr. Steinman that our present four-year undergraduate engineering program is entirely inadequate as training for any class of engineers. The purpose of this short paper will be achieved if it stimulates a study to determine whether it is feasible to have a four-year undergraduate engineering program which will include both the liberal education which all of us desire and also the engineering fundamentals which we simply must have in every engineering program. The speaker knows of no present curriculum which fits his specifications, although the general aims of the undergraduate curricula of Stanford and Stevens seem to point in that direction. The undergraduate curriculum which the speaker has in mind might well follow rather closely the suggestions for undergraduate study given by Professor Sorensen in the November, 1939, issue of the JOURNAL, especially if the curriculum included introductory courses in accounting and management, which Professor Sorensen apparently would postpone entirely to the graduate part of the program.

As far as the speaker can determine there is no conflict whatever between the proposals made in this paper and the recommendations of Dean Hammond's committee as published in the March, 1940, issue of the JOURNAL.

QUESTIONS AND ANSWERS

Chairman Gilkey: We have now come to the second phase of the program; questions from around the table and these will be limited to two-minute answers.

Franklin Thomas: I wonder if it would not be helpful if we get one man's opinion and definition as to what constitutes humanities and to what extent do economics, such subjects as business law, contracts and specifications qualify as to humanities?

R. E. Doherty: I think the best way to answer that question is to say that fortunately it is not necessary, so far as an understanding of the report is concerned, to define "humanities." The Committee defined a number of objectives, and then having done so, invented a name or heading for these involving the word "humanistic." The objectives are stated in terms of competencies to be achieved by the student by the end of the senior year. I would simply answer by saying that those six items of competency are supposed to be the guiding stars in designing a program and that the question of definition of what is humanistic may well be referred to the dictionary or to anybody's individual opinion.

Professor Thomas: I think I am right where I started.

H. E. Wessman: I should like to ask President Doherty a question which he has already answered, but upon which I would like to focus more attention.

At those schools where colleges of liberal arts are located on the same campuses with colleges of engineering, it is only natural that non-technical electives in the college of liberal arts would be made available for engineering students. In reply to a question which I asked a number of men at different schools, they have indicated that they are increasing the number of non-technical electives in the humanities and social sciences, but they are having difficulty in getting students to elect these non-technical courses because technical courses and other options may also be chosen.

Do you believe, President Doherty, that students should be given a free choice in the non-technical field, or should they be required to take definite courses in the humanities and social sciences which have been planned specifically for the engineering student?

President Doherty: I think the answer to that question depends altogether on whether or not you accept the plan of these two stems of study. If you do, then if the calculus, for instance, is indicated in the scientific-technological stem you would require, and do require, the student to take it. If, in the humanistic-social stem, any particular subject matter or course or procedure is indicated in order to achieve the purposes outlined therein, then, it is only rational to say you would also require it.

If, on the other hand, you don't accept the proposed plan but instead merely assume that a student will become educated by taking a course in some kind of economics, or in some kind of history in a particular period, or in something else of that sort, why, then, the only thing to do is let him choose; or if he doesn't want that, let him choose a technical elective.

It depends altogether on whether or not you accept the recommendation in the report.

E. L. Moreland: I would like to ask whether a subject, which might be a technical subject in one curriculum, would be admissible as to what I called a general subject in my outline for a man taking an entirely different curriculum. I can perhaps point my question by asking purely as an example whether it would be admissible to permit an electrical engineer, for example, to take some general course, such as a general course in geology, as a broadening general subject? It is not certainly purely humanistic, but I would like to have your view as to whether that is the type of thing that would be considered as broadening a man's point of view and broadening his culture.

President Doherty: I would answer immediately that it is broadening and might improve his culture, but again I would say that whether I would include it or not would depend upon whether, in my judgment, it helped to cultivate any one of the six items in the humanistic-social stem.

Dr. Wessman: Dean Hammond wants to see a reduction in the total number of credit hours required for graduation from the four-year undergraduates' curriculum. You will remember in the S. P. E. E. report ten years ago 144 credit hours was recommended as a desirable number.

I believe the University of Pennsylvania has recently adopted a curriculum which reduced that to 136 credit hours. Now, there are many schools that still require more than 144, but I had hoped that Dean Hammond would be here to explain his views on that matter because so many of my colleagues have felt that the 144 credit hour valuation was somewhat fictitious, where you combine one lecture hour and two clock hours of preparation, to give you three clock hours as a part of these 144 hours.

They point out that many of the students, instead of using two clock hours for preparation, probably use one clock hour for preparation and one clock hour for play, so we question whether or not an actual reduction in the required credit hours for graduation would accomplish Dean Hammond's purpose which is to insure a more thorough training in fundamentals.

I am inclined to believe that a revaluation of our old system would be better. Suppose we had a three-hour lecture course, three lecture hours and six outside hours, let's make it a four-hour lecture course and four outside hours, in other words, one hour of preparation for one hour of lecture in class. You decrease the total number of clock hours, and at the same time you are increasing the total number of hours when the student is in class, in a consultation, or under the supervision of his own faculty member.

I. C. Crawford: I should like, if I might, to point a question, or ask for an explanation from President Doherty again with regard to one of the planks of the platform in the humanistic social stem. On page 1 of this report and under the Humanistic Social, fifth point, it is stated that studies should be directed toward "the development of moral, ethical and social concepts essential to satisfying personal philosophy to a career consistent with the public welfare and to a sound professional attitude." I have been a little bothered in reading this over in trying to determine just what courses in the university curriculum were available which would lead toward this result in the long run, specifically lead to that, or as to whether we should create new courses pointed exactly at this paragraph No. 5?

How are you handling it at the Carnegie Institute of Technology, Dr. Doherty?

President Doherty: By the latter—a new course.

Chairman Gilkey: We have entered the third stage, questions from the floor.

George L. Sullivan: I would like to ask Dean Moreland if he cares to enumerate more specifically the subjects which he included under general subjects, I believe. He enumerated a number of subjects among which were English specifically and then included a number of others under general subjects, I think, and I wonder if he would care to enumerate the subjects that he had in mind.

Dean Moreland: I think I can probably give you a good example by the kind of thing that we, at the Institute of Technology, classify as general subjects, subjects of this general nature: history of science, history of mathematics, geology, history, United States and Latin-America, history of engineering, history of the far East, social and industrial history of modern Europe, military history and policy of the United States, development of transportation, development of community planning, economic geography, and they come under the heading of history of science and thought. Then, we have various headings under literature and fine arts, contemporary English literature, contemporary European literature and a large number of foreign literature; then, under social sciences, introductory psychology, humanics, a study of human relations, comparative political institutions and subjects of that character.

There is one thing I didn't say in my hurry as I read my suggested program. In providing for election of general studies in the last two years those general studies should not be selected just hit-or-miss. They should be selected to form a part of a well coordinated program, and care needs to be exercised and supervision needs to be exercised to see that elections are made according to that pattern.

C. J. Freund (University of Detroit): If I understand the recommendations of the committee it is proposed that preparation for strictly professional work of the kind Dr. Steinman has in mind shall be accomplished in a fifth year. Does it follow, in the opinion of the committee, that ordinarily only those who complete that fifth year shall be able to qualify later for state registration?

President Doherty: Well, I think the answer is no. The graduate may extend his formal study more than one year; it may be two years or three years; or he may continue study on his own or in industry or elsewhere. I think that it isn't necessary to continue formal education in order to pass the State Board examination or qualify for license. The essential is *further* study; not where it is done. The basic preparation, however, can be com-

pleted in the four years, and this will make that additional study possible.

K. O. Thompson: One phrase in President Doherty's paper, I think, needs to be brought out into the open. Put as a question, who makes up the curricula in the institutions? There has been a good deal of disturbance on the part of some that I have sensed from observation as well as conversation. Suppose a Dean is chairman of the committee on curricula or courses of study? Suppose the head of one of the engineering departments determines the proposed changes from time to time? Is it all in the nature of a compromise and a give and take, or is it always the different departments claiming more than they expect to get? I suppose that has been true of the humanistic social group, at least, and I would like to make a plea that if there is a standing faculty committee on courses of study at least one member of the Department of English or economics, or whatever other name the school may have for that department, be represented on that standing committee of courses of study and be recognized as having an equal right to say and plead for the work of his department. Obviously he can't tell the requirements in the engineering field, but he ought to have a voice in the proportion and the content of the courses in this humanistic social group.

Chairman Gilkey: I think the suggestion is a perfectly reasonable one. That gets into the inside handling at different institutions and, therefore, is quite without the scope of this committee. We can't say who makes out those curricula, but on the other hand we can sympathize with anybody who is not getting properly represented in the making out of the curricula.

H. H. Bliss: Most of us who took our engineering education as long ago as I did found that this attention to the humanistic English and that sort of thing was not given in those days. We came out of it without very much of what might be called general education.

Now, genius was defined for us the other day by Professor Bangs as a man who does not make the same mistake once. We are not that kind of a genius and we have made this sort of a mistake and we find now that the graduates of our institutions and the employers to whom they go are complaining that our students lack in ability to express themselves in English, ability to appreciate and understand things and some understanding of the humanistic and social outlook.

It seems to me a very fine thing that the committee is doing what it can to remedy that situation and, of course, we all know there are some institutions such as California Institute which have paid a lot of attention to that matter for a number of years now.

There is one thing, however, that I have missed as an explicit expression; I hope it is implicit in the report. Some attention it seems to me, should be given to preserving and developing the independence of mind of our engineering students.

Under the pressure of the curriculum, as it has been administered in the past and seems to be administered in many places now the student is told to take it or else.

We ought to feel that a student is going to face a future in which the responsibility of engineering and the sciences for the use of his products shall be shared by the engineer and the scientist. He, perhaps, is more responsible than almost everybody else and if he doesn't preserve his independence of mind, if he isn't equipped to stand against governmental pressures and pressures of all kind, how are we going to have him help in creating the better world that we are hoping for?

S. W. Dudley: I have been thinking of a problem that has bothered me in the consideration of this entire question, namely, an element which has not yet been mentioned except very casually, in connection with the number of total credit hours required. The total credit hours share with the marking system the quality of being elusive and rather indefinite. I wonder if, in the committee, where presumably the general thinking of the engineering schools throughout the country was more nearly cross sectioned than it has been heretofore, there was any consideration given to the total amount of the students' time throughout the day or the week that might be considered normally addressed to his scholarly work.

Now, industry has turned from the 50 hour week to the 40 hour week to the 30 hour week. One of the first things which President Doherty did when he became Dean of the Engineering School at Yale was to study that aspect of the curriculum with the result that the total amount of time required in the sophomore year was materially reduced.

I wish to ask the committee if a total number of hours including actual class room attendance or laboratory attendance and outside preparation per week had been considered? Is the total amount of the student's time directed to studies on the average supposed to be 54 hours per week or 48 hours per week or 44 hours per week? What would be considered a generally reasonable demand on the student's time?

In asking this, of course, I realize the great differences that exist between students at the upper and the lower ends of the ability level.

Chairman Gilkey: Dean Dudley, the committee as a whole did not consider those things but, of course, individually a great deal of thought is being given to them. For supplementing that

I think I shall make it D. vs. D.; Yale past vs. Yale present; President Doherty.

President Doherty: I think it would be better for somebody else to discuss that question. However, I look at the question of how many semester hours a student should be scheduled for, in the same terms as I look at the question of what specific courses, what subject matters ought to be covered. I think it depends on what you are trying to do.

It is my impression that the thing that has come to determine the number of semester hours has no very direct relationship to educational objectives, but rather has grown out of different opinions as to the limits of physical endurance of the students. Those who think students can stand 200 semester hours will have that, and those who feel that the students can stand less, will have less. I contend that education can't be reliably measured in semester hours.

I should perhaps state it another way around: I would propose that if one could come nearer achieving the educational objectives toward which the program is aimed by requiring one-half as many semester hours, why, then, that is what one should require. I would do those things and keep the student steamed up to that level of activity and study which would achieve for him the maximum progress toward those objectives. Then after I had done this, and not at the beginning, I would, if necessary, try to translate this into semester hours. On one thing I am clear: if a student's time is so completely scheduled on so many different things that little time is left for genuine thought, he can't possibly make progress contemplated in the Committee's report.

My thoughts on this, as you will realize, are a little bit radical, but they appear rational to me.

C. Francis Harding: Among the almost innumerable accomplishments of the dean of engineering listed last night one was recently developed in which I think many might be interested in connection with this problem, namely, the adoption of two new curricula, not interfering in any way with the four year curricula nor the graduate M.S. curricula. We have curriculum B now in all of the engineering schools. We require the fifth year, but that includes no more content than our usual four year curricula. It was introduced for two purposes, one to meet the needs of those who have been poorly prepared in the high schools and couldn't do a good job in four years with our rather rigorous curriculum, but who should early in the four years determine that five years is preferable and, furthermore, to permit those more able students to take a large percentage of additional physics and mathematics

and the humanities throughout a five year period and still only get the B.S. degree, but have a broader training.

The other, curriculum C, will take two or three years beyond the requirements of the B.S. degree, but not necessarily leading to it. It does require a certain percentage of additional physics and mathematics and the broader subjects of the humanities, but is elected early in the undergraduate years supposedly for a very broad training, so the degree of that longer course has not yet been determined, but it has been proposed as being a B.S. degree only with additional humanistic subjects credited.

Chairman Gilkey: That is certainly some very interesting experimentation.

T. T. Read: I got the impression from President Doherty's presentation and also his comments that, perhaps, he has implicitly in his mind the idea if we can only determine what kind of an educational structure it is we want built it will be rather simple to build it after we arrive at that determination.

I want to make the point I don't think that is true at all, that this constructing of an educational sequence is quite a different thing from constructing a building, where you can write out specifications of certain kinds of floors, what kind of an area; what kind of windows in that area and so on.

We are up against the fact, after we have laid out this curriculum, which we write out like specifications for instruction, you still have the fact that Professor Smith and Professor Jones have to handle this three hours or four hours of preparation which are assigned them. What Professor Jones or Professor Smith actually do with those three or four hours is different from what the specifications indicate. I know of no institution—perhaps this reveals my ignorance—but I know of no institution in which there is any provision whatsoever for indicating to Professor Jones or Professor Smith that their conduct of that two hours or three hours which is assigned to them is any less than perfection.

Perhaps deans in the privacy of their interviews with the professors are able to convey this idea to them, but certainly I don't think colleagues are able to, and perhaps colleagues have more strong ideas on this subject than deans have. We will always have that question.

Having laid out you are going to have a certain amount—it is rather like a cocktail; you specify so much bitters shall go in to it. That is all right because the bitters come in a bottle which is standardized. When you say so many drops you get so many drops, but when you get two hours of a humanistic subject in an institution it may be entirely different from what you get out of a humanistic subject in another institution, so I sound a pessimistic

note which I think we need to recognize because, after all, they say a pessimist is a person who has to live with an optimist.

I think that this is really one of the most difficult things about this problem from the educational standpoint, the question as to what is actually done with these hours which we assign. For instance, there is such a thing you assign two hours plus four hours of preparation and one man interprets that with his optimistic view that the average student ought to be able to do what he assigns them to in two hours. As a matter of fact, you find these students are actually taking ten hours to accomplish what that man requires of them in order to pass the subject.

You find another man who has two hours assigned to him, four hours of preparation, and he handles his work in such a way, as you say, the student—and correctly, I think—the student devotes this preparation time to play and who, I dare to say, perhaps, gets more good out of it than he does out of doing geography.

Chairman Gilkey: I think we recognize certain experiences common to many of us.

A. H. Fuller: A question by Dean Crawford a short time ago suggested that perhaps all of us do not have in our institutions the proper courses for bringing out the six objects of the committee.

In President Doherty's reply he admitted that Carnegie Tech was providing new courses. It would be very interesting to know what those new courses are. It might be more fun for each of us first to go home and study the situation and see what we can do and then to pool our experiences later.

One thing in that connection comes to my mind: At Iowa State a few years ago a required course in the appreciation of art consisting of one lecture throughout the whole year was injected. After three or four years of experience the indications are that possibly this is distinctly worth while. Another way, of course, of bringing out the six objects is for each one of us in each one of our courses to see what can be injected to bring out these things.

I would like to raise the question as to the content of these special courses if the committee is ready yet to discuss that phase of the question.

President Doherty: I think the content of courses is a matter of academic judgment. This judgment differs at different institutions with different people. But in the plan the courses might be existing courses, or new ones. The essential thing is that the courses should be organized with unity into a logical sequence that would answer the purposes of the report's proposal; and if it did that, it would answer the question.

The question which was directed to me was what we did at Carnegie Institute of Technology. My answer was that we de-

signed a new program. That isn't to say there aren't one hundred other ways that would be equally effective. I am sure that while every member of the committee certainly doesn't agree with everything that I think, I yet believe that we all agree that whatever else is done, a program should be designed—an integrated and related program—that has unity from beginning to end, and a unity that will be recognized by the student.

Chairman Gilkey: I wonder if any other member of the roundtable group would like to contribute to that?

How about you, Dean Moreland?

Dean Moreland: I might emphasize what I said in my postscript, that these humanistic studies need to be developed into a coördinated program. They can't just be picked off the shelf here and there and get anywhere. We have not yet made any comprehensive study of our curricula; something has been done on it.

Our particular organization at M. I. T. perhaps, is a little unusual. We have the Dean of Engineering who is in charge of the engineering courses; we have a Dean of Humanities, who is in charge of all of the service courses of economics, English, philosophy, and so on, and the English and general study courses are directly in his purview. He is completely coöperative with the Dean of Science and the Dean of Engineering and he is making a very intensive study of what he calls the program of general studies, but it is just the same thing that we are talking about here.

We have not yet made any sweeping changes in our program, but we think our program conforms fairly generally with this specification now, and we hope to make it conform more closely.

We do, however, in our case interpret some things to be in the humanistic social stem that, perhaps, President Doherty would rule out.

As I rather implied, I think, in my question, we rule that a student may elect in these non-technical electives or general studies subjects which may be required subjects in some of the other technical courses, such as geology or biology, if he is not working in those fields, I believe other than that brief observation, I have nothing to contribute.

S. B. Morris: I am rather impressed, in discussing the bible as it has been referred to here, that we have on the platform both the liberal and the fundamentalists representing its interpretation. I would like to ask this question: Whether a person, well trained in all the fundamental sciences, and I would include the sciences of biology and the earth science of geology as a part of the preparation of all engineers as far as possible and if the engineer does take the broad field of science in that matter and gets the understanding or the universality of science hasn't he gone a considerable

way towards the aid of his personal philosophy which was item No. 5?

I think, perhaps, in a way it would be considerably more effective than the particular course which was going to be installed to help a man develop a personal philosophy. It is sort of like giving a course in happiness.

Dean Crawford: I think I have no comment to make on the specific question asked by Dean Morris. However, the question as a whole, I think, resolves itself into this: That each and every institution must solve the problem by its own particular resources and after a very careful consideration by the faculty as a whole as to what they consider the proper courses and the proper men to give those courses in the university or the school concerned.

President Doherty: Mr. Chairman, I can't let that go by. The report doesn't recommend courses in happiness or courses in human philosophy. It simply sets down ends to be attained and whether they are attained as by-products or as the direct result of courses taken makes no difference. If they can't be attained directly by courses, then, they should be attained other ways, as by-products for instance. And even if we don't know how to do it yet, as may be so, if different ones of us try different ways, we will ultimately learn how to do it. So may I once more repeat that these specifications in the report are not specifications of courses; they are specifications of ends to be achieved.

D. S. Bridgman: This observation may be a little outside the scope of this particular discussion, and yet a good many of the questions seem to me to raise the problem not only of curricula, but of the individual student and the way in which you are going to help him make the particular selection that is going to be most useful to him, and it seems to me that as you shift from content and perhaps rather specific objectives in your engineering curriculum, to rather broad aims of the development of the individual, it is going to be necessary in the engineering schools to have more of your personnel and counseling procedures than you have had before.

I am wondering, for example, at M. I. T. where they have in their freshman year, as I understand it from rather meager knowledge, such options as scientific thought and English composition, whether they don't find that it would be desirable to have pretty careful counseling of the individual student as to which one of those options he might well take. Some of them, I think, have a tendency to flounder with one option who might gain a good deal from another. I am wondering how Dean Moreland grapples with that problem.

Dean Moreland: We require English composition; we don't give any of them a chance to duck that in their freshman year, and I am quite a booster for that myself. I have been in the engineering profession; I recognize the need of English more acutely, perhaps, than some that have been in the teaching profession. That is one of the things that I have been pressing very hard, to increase our English content, and we do require English composition in both terms of the freshman year.

A Voice: Possibly it is the sophomore year.

Dean Moreland: I think it is the sophomore year where they get an option for a general study and they are there allowed a good deal of latitude, but by that time we are beginning to get a line on the students.

Now, we have a system of student advisors; we happen to call them registration officers because one of their major duties is in helping the student work out his registration program at the beginning of the term. Those officers are divided by courses so that no one man deals with a great many students and the hope is, at least, that they get sufficiently familiar with the students to be able to give them some intelligent guidance in the selection of their general studies.

I know that we can't do a perfect job at it, but we do try to see that a student selects subjects which are not only coördinated among themselves, but are suited to the student's particular needs.

H. S. Rogers: Most of our questions this morning have been directed toward the humanistic social stem. I take it that we have more or less of a common understanding of the objectives of the scientific-technological stem, and that the former is more perplexing to us.

I would like to ask a question of Dr. Doherty regarding the objectives in the humanistic social stem, and I don't mean by that in English composition, because I would rule that out and classify it with drawing and mathematics, but I mean the objectives of such courses as economics and sociology and pathology, literature and all of the humanities.

We can't hope to achieve any critical understanding in the time available to us. In our objectives are we not primarily after points of view, attitudes, appreciations and tastes?

I would like to ask if Dr. Doherty thinks it is consistent to work toward those objectives of such a nebulous nature in terms of credit hours and grades.

President Doherty: Yes.

Secretary Bishop: The main criticism that has come to me through correspondence and in personal contact has been stated

crudely in this way: That the committee proposes to remove all engineering from the engineering curricula and to give an A.B. degree. I think that should be somewhat clarified because there are people who have read the report who really believe that the proposal is to postpone engineering education until after we have had four years for an A.B. degree.

Dean Moreland: I can certainly speak for myself as a member of that committee that we do not and did not intend to convey any such impression. We intended to leave both the humanistic social and the scientific technological stems in force, and I think it is unquestionably the view of the committee that the major emphasis will be on the scientific technological.

I think there is a paragraph somewhere in the report that says that we must never lose sight of the fact that our objective is basic engineering education.

There has been a suggestion in the report that in order to get as much of the broadening social humanistic work as is necessary, it may be necessary for some of the institutions to postpone some of the work that they are doing, or work that they would like to do in the undergraduate curriculum, to later years, but there certainly is no thought on the part of the committee that we would delete the basic engineering subjects and scientific work which prepare a man to take his place in engineering work in industry.

Chairman Gilkey: Sometime in my youth I heard the statement that the time for a person to leave the table was when he felt that he could handle just one more piece of pie. That time has come for us. Thank you for your coöperation.

THE MODERN HOSPITAL AND ITS TECHNOLOGICAL STAFF

By H. N. WALKER

Associate Professor of Electrical Engineering, New York University

In these trying times when young men graduating from our universities and colleges find it difficult, if not impossible, to get jobs it is heartening to find that there is a slowly growing demand for the electrical engineer and the physicist in the technological departments of the larger hospitals. This need has risen as a direct result of the increasing applications of electricity to the practice of medicine. Today, more than ever before, numerous electrical devices are being employed as diagnostic, therapeutic and surgical aids; their more general acceptance is increasing. Jobs, therefore, will continue to open up in a field which, fortunately, will take some years to saturate.

The medical profession, for a long time realizing the importance of certain applications of electricity, is slowly beginning to realize the importance of a properly trained personnel to handle these necessary adjuncts to their professional practice. Towards this end one frequently hears sentiments favorable to the employment of the electrical engineer and the physicist in the modern hospital.

However, there is considerable inertia within the medical profession which must be overcome before the employment of the electrical engineer or the physicist becomes a matter of general practice. Hospitals, which occasionally conduct research projects, often find it convenient to call on equipment manufacturers for help in setting up the required electrical apparatus and, unusual as it may seem, some hospitals have occasionally made use of their maintenance corps. The medical staffs of these hospitals realize that the situation is undesirable and often intolerable. Some hospitals of the teaching type are more likely to employ a physicist or an electrical engineer on a consulting or on a full-time basis. A few of the more heavily endowed hospitals in the New York City area employ one or more engineers on a full-time basis, but these are the exception rather than the rule.

The author is familiar with at least one instance where budgetary considerations do not permit the employment of even a consultant with the result that in the study of one problem the medical investigator had to develop the electrical features of his problem

without the aid of a competently trained engineer. Needless to say, this proved to be a laborious and wasteful task for which the investigator was poorly prepared and in which his greatest capabilities could not come into play.

The practice of modern medicine has become and will continue to become more of a science and less of an art so long as it counts among its practitioners, men with the insatiable desire to run down the very last of man's ailments. As is well known, investigations of the most penetrating nature, those which seek to establish fundamental relations between cause and effect quickly overstep the man-made boundaries which encompass and differentiate one science from another. For this reason, it is quite apparent to all medical investigators that a knowledge of the fundamentals of electricity and magnetism, hydraulics, electronics, mathematics, high frequencies, optics, and numerous other phases of science are indispensable and will play increasingly important roles in the solution of their problems. The modern medical school includes little or nothing of these subjects in its curriculum. This phase of medical research, therefore, offers opportunities to the electrical engineer and the physicist who is willing to continue his studies into the fields of biology, physiology, and anatomy. Mention of only a few fields of medicine involving knowledge of the technological subjects enumerated above includes:

Physiotherapy: Direct and low-frequency currents are used by direct application to the patient for muscle and nerve stimulation and for the introduction by iontophoresis of various drugs into the body. High-frequency currents from 500 to 100,000 kc. are used to produce heat in the body. In this way, high currents can be passed through tissue without nervous or muscular response. The heat produced acts to increase blood circulation (possibly by lowering its viscosity); the increase of circulation is believed to be the basis of the beneficial action of this type of therapy.

Electroencephalography: Local voltages of about 0.02 to 0.10 millivolt are generated in the cerebral cortex and are detected by small electrodes firmly attached to the scalp. These voltages are amplified and recorded. The records show at least two important periodicities. One is approximately 10 cycles per second, the other about three times as much. Numerous studies have been made on the interpretation and correlation of these records. This technique is new but seems to warrant further extended study, not the least of which will be along the lines of improving the apparatus and in analyzing the resultant wave forms. The method has proved to be useful in determining the site of brain tumors and in localizing other mental derangements.

Haemodynamics: The study of the dynamics of blood flow is essentially a branch of hydrodynamics as applied to the pumping circuit presented by animal organisms. This subject involves many theoretical and clinical concepts, including the action of the heart, blood pressure, the pulse and its pressure, velocity of the moving column of blood, arterial lateral and end pressure, stroke volume, and numerous other factors. The engineer readily can call to mind terms used in the practice of his profession which have meanings analogous to those above.

Chronaxie: This is the study of muscle nerve degeneration. It is based on the time interval between the discharge of a condensive circuit through a nerve center to produce muscular contraction. The concept of the discharge of a condenser through a high resistance circuit, such as a gaseous tube, may prove somewhat analogous.

The neurologist occasionally makes use of devices which discharge definite quantities of electricity through certain sensitive regions of the skin and observes muscular response. The neurosurgeon makes use of electricity in connection with the tools with which he uncovers the brain, and in the use of the electric knife in brain surgery.

That the medical profession is investigating these fields (along with a host of others not mentioned) requiring a technological knowledge is sufficient proof that there is a demand in the modern hospital for one possessing the requisites to supplement the available medical knowledge. However, it must be borne in mind that the electrical engineer or the physicist who enters this work must possess rare qualities, not the least of which is a willingness to work diligently, tirelessly, and coöperatively. This last is of extreme importance in the establishment of a matter-of-fact acceptance of those technically trained. It was once mentioned to the author that it was virtually impossible to *"secure intelligent coöperation on the part of physicists or electrical engineers in the construction of new apparatus. Somehow, the engineer seems to shy off research problems of the variety that engages the neurophysiologist. It has been our experience that it is easier to train a biologist in electronics than it is to train an engineer in biology."* Indictments of this nature surely cannot be true of electrical engineers or of physicists in general. It is indeed unfortunate that due to lack of coöperation the technological development of medical science should be retarded.

The obvious fascination of contributing even in a small way to the conquest of one disease should and will transcend all pettiness which may have crept into the workaday relations of two or more

people with different trainings; trainings which it is becoming more and more evident are necessary and sufficient for the solution of the varied and complex problems confronting modern medicine.

It is hardly to be expected that hospital heads will flock to the engineering schools for their graduates. They first need to realize what their own technological problems are, and this in itself will take time; secondly, they need to realize that the employment of a full time technological assistant is more satisfactory and efficient than the use of either their maintenance corps or equipment manufacturers, and thirdly, they must know that they can depend on the product of our engineering schools.

This last item places a burden on us, and one which we cannot shirk, for, indirectly, it is our individual contribution to the advancement of human welfare, a subject which vitally concerns every one of us. A partial curriculum which would best fit the engineer to enter this work so as to be of most help involves many factors, but the technological subjects mentioned earlier will serve to point the way. X-ray technique is of extreme importance and recent improvements in this equipment have been largely due to the work of the physicist and the electrical engineer.

The opportunities for original scientific work in this field are abundant. The pioneering aspect will no doubt attract to this field some of the more fertile brains of engineering. Salaries, at present, are about equal to those of other lines of engineering endeavor.

The author has long felt that the electrical engineer or the physicist who fails to consider this field may be overlooking a life's work which can easily prove fascinating and financially stable, one which is laden with possibilities for original investigation and technological advancement and one which is intimately connected with the alleviation of human suffering.

SECTIONS AND BRANCHES

Allegheny Section.—The **Carnegie Institute of Technology** was host to the Allegheny Section of S. P. E. E. for its Sixth Annual Meeting and Banquet, held on Friday and Saturday, October 25 and 26, 1940. The business and technical sessions were held in the Theatre of the College of Fine Arts on the campus of the Institute. The main theme of the meeting was "The Coördination of Engineering Curricula." Leaders in engineering education and industry from the Middle Atlantic States participated in the sessions, 352 members and guests being in attendance. Two representatives of the Engineering Institute of Canada, L. A. Wright, General Secretary of the Institute, and C. R. Young, who represented President T. H. Hogg of the Institute, also attended. The following national officers of S. P. E. E., D. B. Prentice, President, F. L. Bishop, Secretary, and Nell McKenry, Assistant Secretary, also helped in conducting the meeting.

The Friday afternoon session was opened by the Chairman of the Section, E. M. Pugh, of the Carnegie Institute of Technology. He introduced R. E. Doherty, President of the Institute, who welcomed the members and guests to the Carnegie Tech campus. F. C. Stewart of the Pennsylvania State College and Vice-Chairman of the Allegheny Section responded for the Section and invited the Seventh Annual Meeting of the Allegheny Section to the Pennsylvania State College on November 14 and 15, 1941. This invitation was unanimously accepted. The Committee on Nominations of which C. S. Keevil of Bucknell University was Chairman presented the following nominations: F. C. Stewart, Chairman, L. D. Hayes of West Virginia University, Vice-Chairman, and A. P. Powell of the Pennsylvania State College, Secretary-Treasurer. These nominations were approved. The Chairman then turned the meeting over to President D. B. Prentice for the first technical session.

This session was devoted to an examination of proposed changes in engineering college curricula, placing emphasis on the basic scientific-technological studies and an integrated social relations program. The speakers were E. D. Smith, Master of Saybrook College and Chairman of the Department of Economics, Yale University, on Fundamentals of Professional Education; W. E. Wickenden, President of Case School of Applied Science, on The Scientific-Technological Stem of Engineering Education; and W. E. Hotchkiss, Maurice Falk Professor of Social Relations, Carnegie

Institute of Technology, on The Social-Humanistic Stem of Engineering Education. Prepared discussions were presented by Nathan Miller, B. R. Teare, Jr., and L. T. Lawler, all of the Carnegie Institute of Technology.

The second technical session, held on Saturday morning, was presided over by R. E. Doherty, Chairman of the Engineers' Council for Professional Development. The session was devoted to an analysis of the coöperation between engineering colleges and industry and liberal arts colleges. The speakers were Walther Mathesius, Vice-President of the United States Steel Corporation of Delaware, on Coördination of Industry with Engineering Colleges; W. P. Tolley, President of Allegheny College, on Coördination of Liberal Arts and Engineering Education—3–2 Plan; and Douglas F. Miner, George Westinghouse Professor of Engineering, Carnegie Institute of Technology, on Coöperative Engineering Education. Prepared discussions were presented by R. F. Mehl, W. R. Work, both of the Carnegie Institute of Technology, and J. H. Belknap of the Westinghouse Electric and Manufacturing Company.

While the technical sessions were in progress, there were concurrent events for the ladies. On Friday afternoon a demonstration of stage costuming and make-up and a presentation of "The First Dress Suit," a one-act comedy, were given in the new Laboratory Theatre of the Department of Drama of the Carnegie Institute of Technology. Elizabeth S. Kimberly, of the Department of Drama, was in charge. On Saturday morning a tour of the current exhibition of "A Survey of American Painting" in the Galleries of the Carnegie Institute was conducted by Mary G. Carter, art critic.

Several social events were held in connection with the meeting. On Friday afternoon a reception was given by President and Mrs. R. E. Doherty in the Exhibition Room of the College of Fine Arts. On Friday evening the Sixth Annual Banquet was held in the Boggs and Buhl Dining Room. The toastmaster was W. N. Jones, Director of the College of Engineering, Carnegie Institute of Technology, and the principal speaker was C. F. Lewis, Director of the Buhl Foundation. The topic of his address was People Still Reach for the Stars. Subsequent to the banquet, a performance of "Christopher Columbus" was presented in the Theatre of the Stars, Buhl Planetarium, A. L. Draper, Director of the Buhl Planetarium, being the lecturer. Following the performance there was a special demonstration of the operation of the Planetarium.

On Saturday afternoon those attending the meeting were guests of the Carnegie Institute of Technology at the Case vs. Carnegie Tech football game in the Stadium. After the game a social hour

was held in the University Club. In the evening a special performance of a Pultizer Prize play, "Craig's Wife," by George Kelly, was given by the Department of Drama of the Carnegie Institute of Technology in the Theatre of the College of Fine Arts. Douglas McLean was the director.

The guides and ushers for the meeting and social affairs were student members of the national honoraries, Tau Beta Pi, Theta Tau, Mortar Board, and Cwens.

Because of the many favorable comments on the meeting and the papers presented, the Carnegie Institute of Technology has decided to publish the proceedings of the meeting in booklet form. These will be available for distribution soon. Some of these papers will be reprinted in the JOURNAL OF ENGINEERING EDUCATION and in the Journal of the Engineering Institute of Canada.

J. B. ROSENBACH,
Secretary

The Fall Meeting of the **New England Section** was held at The University of Connecticut, Storrs, on Saturday, October 9. The total registration was 293 members and guests. Registration was held from 9:00 A.M. to 10:00 A.M. in Room 213 of the Engineering Building.

A. Chemical Engineering. Attendance 21. Chairman: T. S. Crawford, Rhode Island State College.

The Place of Industrial Chemistry in the Chemical Engineering Curriculum, C. C. Furnas, Yale University.

How Best Can the Factual Material in Chemical Engineering, such as Materials of Construction, Instruments, etc., be Taught? O. T. Zimmerman, University of New Hampshire.

The Objectives and Subject Matter of a Course in Chemical Engineering Design, H. Bliss, Yale University.

B. Civil Engineering. Attendance 28. Chairman: R. R. Skelton, University of New Hampshire.

A Five Year Curriculum and What it Should Contain, W. S. Evans, University of Maine.

A Study of the Number of Subjects and Hours which Should Constitute a Normal Student Load, C. O. Dohrenwend, University of Connecticut.

The Genesis, Evolution and Mortality of Courses:

1. Courses of Construction, F. W. Stubbs, Jr., Rhode Island State College.
2. Fluid Mechanics, A. N. Vanderlip, University of Connecticut.
3. Structural Courses, E. A. Gramstorff, Northeastern University.

C. Electrical Engineering. Attendance 50. Chairman, R. G. Porter, Northeastern University.

Preparation for Placement, M. M. Boring, General Electric Company.

The Implications of Engineering Registration and Licensing Movement on Electrical Engineering Education, W. C. White, Northeastern University.

D. Mechanical Engineering. Attendance 44. Chairman, H. D. Watson, University of Maine.

The Purpose and Scope of Mechanical Engineering Laboratory Courses, F. W. Keator, Yale University.

The Industrial Side of Mechanical Engineering, W. E. Addicks, Boston District Manager, Cutler-Hammer, Inc.

E. Mathematics. Attendance 30. Chairman, R. D. Douglass, M. I. T.

Mathematics and Descriptive Geometry, J. T. Rule, M. I. T.

Descriptive Geometry and Mathematics, H. A. Wood, University of Connecticut.

F. Economics and Social Studies. Attendance 11. Chairman, F. H. Crabtree, Tufts College.

Principles of Economics for Engineering Students, R. V. Hobbah, University of Maine.

Engineering Economy in the Engineering Curriculum. G. W. Case, University of New Hampshire.

G. English and Engineering Education. Attendance 22. Chairman, H. W. Melvin, Northeastern University.

Possible Uses for Basic English in Freshman Composition Classes, Winthrop Tilley, University of Connecticut.

Our Freshman Composition Problem and New Hampshire's Solution, H. H. Scudder, University of New Hampshire.

From 12:30 P.M. to 1:30 P.M., 201 members and guests enjoyed luncheon in the Dining Room of the New Girls' Dormitory. Following the luncheon a brief business meeting was conducted with Professor Morgan presiding. Professor Morgan introduced Dean Brammell of the School of Education who welcomed the group on behalf of the University of Connecticut. The Secretary read the minutes of the Northeastern University meeting and gave the financial report for the year ending October 14, 1940. Both the minutes and the financial reports were approved.

Professor Morgan announced the appointment of a Nominating Committee consisting of W. C. White, Chairman, and R. W. Wales,

and J. A. Bullard, W. H. Bliss, E. W. Bowler, and A. G. Conrad. He also announced the appointment of a Resolutions Committee consisting of H. P. Burden and H. L. Hazen and J. P. DenHartog. Both of these committees were requested to report at the dinner meeting. The new deans, Dean Lampe of the University of Connecticut and Acting Dean White of Northeastern University, were introduced. Professor Morgan next called on C. F. Scott, the only past president of the Society present.

Chairman Morgan presided at a General Session. The subject "Aims and Scope of Engineering Curricula" was conducted as a town meeting with the following three speakers: J. W. Barker, Columbia University; E. L. Moreland, M. I. T., Vice-President, S. P. E. E.; Harvey N. Davis, President, Stevens Institute of Technology. Much discussion followed the presentation. The attendance was 146.

G. S. Torrey of the University of Connecticut played the carillon. Following this a sound motion picture showing the manufacture, principles of operation, and application of vacuum tubes was shown. The film which contained an explanation by Lowell Thomas was loaned by the Southern New England Telephone Company.

The annual dinner was held at 6:30 P.M. at the University Dining Hall. The attendance was 209. After the dinner, the Chairman presented President Albert N. Jorgensen of the University of Connecticut, who welcomed the members present on behalf of the University.

W. C. White, Chairman of the Nominating Committee, presented its report, and T. H. Morgan was nominated for chairman for the ensuing year and C. E. Tucker for secretary. The nominees were elected.

The Chairman introduced Admiral Wat Tyler Cluverius, President of Worcester Polytechnic Institute, who gave a very instructive address on "The Naval Factor of Defense."

The following resolutions were presented and unanimously accepted by the section:

"The members of the New England Section of the Society for the Promotion of Engineering Education in annual meeting assembled at Storrs, Connecticut, wish to express to President Albert N. Jorgensen, and to the faculty of the University of Connecticut, their sincere appreciation of the hospitality which has helped so much to make this meeting a success.

"We wish to express our gratitude to the officers of the section, its Chairman, Professor T. H. Morgan, its efficient Secretary, Professor Carlton E. Tucker, and the Committees which have planned and carried out the program for this meeting.

"We wish to thank Admiral Cluverius, President of Worcester

Polytechnic Institute, for his able and instructive presentation of 'The Naval Factor of Defense.'

"The ladies of our party have had a most enjoyable day and wish to join us in sincere thanks to Mrs. Lampe and the members of her committee for their entertainment."

Resolutions Committee:
J. P. DENHARTOG,
H. L. HAZEN,
H. P. BURDEN.

During the morning the visiting ladies were taken about the campus. At noon they were taken by private car to the Martha Fuller Inn in Hampton where a delightful luncheon was enjoyed by the 80 ladies present. They returned to the University at about 4:30 P.M. and joined the men at dinner.

SECRETARY'S FINANCIAL REPORT 1939–40

October 14, 1940

Receipts

Cash on hand October 14, 1939 (after paying printing bill)	$ 6.36
Cash from banquet, 216 at 10 cts. each	21.60
Contribution from one member outside New England	1.00
Refund on postal cards	.74
Interest	.44
	$30.14

Expenditures

Mimeograph	$ 1.47
Post cards	3.75
Printing	2.90
Postage	8.88
Envelopes	1.44
Cash in bank October 14, 1940	11.70
	$30.14
Outstanding bills to be paid for from the receipts of the meeting	$26.25

October 23, 1940

Receipts

Cash in bank October 14, 1940	$11.70
Cash 188 lunches and 199 dinners at 15 cts.	58.05
Contribution from two members from outside New England	2.00
	$71.75

Expenditures

Printing	$24.25
Postage	2.00
Cash on hand	2.00
Cash in bank October 23, 1940	43.50
	$71.75

C. E. TUCKER,
Secretary

MECHANICAL ENGINEERING PAGE

I consider the honest engineer the most valuable asset of this government.—Wm. H. Taft.

R. L. SWEIGERT, Georgia School of Technology, *Editor*

OBJECTIVE QUIZZES IN ENGINEERING

V. M. FAIRES

Agricultural and Mechanical College of Texas

With increasing enrollments and larger classes, there inevitably occurs a need for types of quizzes which can be graded quickly, sometimes by inexpert help. Anyone who has sat down before the combined output of one hundred and twenty students, each having written discussion answers for an hour, well appreciates a primary reason for the development of the objective type of examination in the social science courses. If the same person has large classes of students in engineering courses, he will surely think that objective questions can advantageously be adapted to engineering courses.

In most engineering courses the instructor would like to test the student's knowledge concerning ideas involved in the theory, bits of descriptive matter, and definitions. Even though grading time is not an important consideration, the use of objective-type questions will permit a more complete coverage of such material and yet leave ample time for problems. Thus, questions which can be answered and graded quickly have an advantage which warrants their use, although the instructor for good reasons may not care to use such questions exclusively.

There are several types of questions that may be used, the simplest of which and the easiest to compose being the completion type. In this type of question, an important word or words or an item of information is to be supplied by the student. For examples, I have chosen the general field of machine design. Samples of completion questions are:

	Ans.
1. For a rotating shaft with steady load (no shock), the Code recommends a value of K_m of	_____
2. When the deflection of a bronze shaft is too great, the deflection may be reduced without changing the diameter by making the material	_____

Purists may object to question 2 on the grounds that there is more than one correct answer. Any material with a modulus of elasticity greater than that of bronze would be a correct answer and should no doubt be given full credit. However, steel is the obvious answer. Questions which are similar to 2 are more difficult to compose than those similar to 1. In the case of style 2, care must be used to indicate the type of answer desired, since for example, in question 2 in this case, the deflection could be reduced with the same material by increasing the moment of inertia I.

Another type of question which is commonly used is the right or wrong type. For example:

3. When oil is used in a high-speed ball bearing, the space between the balls should be completely filled with lubricant in order to provide perfect lubrication.	RIGHT WRONG
4. The width of topland of a gear tooth is an important consideration in regard to the heat treatment.	RIGHT WRONG

The student marks out the word (RIGHT or WRONG) that does not apply. In this type of question, the difficulty is generally in framing a statement that is strictly right or wrong. The bright student is likely to be on his guard against being led into the wrong answer, so that statements that can be interpreted as being both correct and wrong will fail of their purpose.

(*To be continued*)

TENTATIVE OUTLINE OF CONFERENCE FOR MECHANICAL ENGINEERING TEACHERS

PURDUE UNIVERSITY—JUNE 29–JULY 3, 1941

Meetings of General Interest (Sunday evening and four mornings):

Sunday dinner meeting—"Aims and Scope of the Mechanical Engineering Curriculum."

Monday morning—"Specialized *vs.* General Curricula." A symposium followed by free discussion from the floor. How much time should be devoted to special application courses; how much free choice of subjects; how much of non-technical courses; what are the fundamentals; where are we tending?

Tuesday morning—"Experimental Laboratory Methods." A prepared symposium followed by free discussion from the floor. Subject matter of laboratory instruction (some other than heat power), effective methods of instruction, experiment *vs.* demonstration, correlation with other subjects, handling of large sections. A pertinent paper on some phase of preparedness as related to education.

Wednesday morning—"Aids to Teaching." A talk and demonstration of available methods and equipment. "Fluid Mechanics *vs.* Hydraulics." A prepared round-table discussion followed by free discussion from the floor.

Thursday morning—"Selecting and Training a Teaching Staff." A talk by an experienced engineering administrator. Source of supply, inbreeding, promotion policy, training, how to eliminate on misfits. "Encouraging Selected Students to Graduate Study." A talk on aims, methods and requirements for graduate study. Requirements for graduate degrees.

Meetings of Limited Interest (3 afternoons, simultaneous sessions):

Monday afternoon—Sessions on
- Heat Power
- Machine Design
- Aeronautics
- Process Supervision

Tuesday afternoon—Sessions on
- Engineering Thesis and Research
- Machine Design
- Management

Wednesday afternoon—Sessions on
- Manufacturing Processes
- Heat Power
- Mechanical Laboratory

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

At the 1940 annual meeting of the Engineers' Council for Professional Development, R. E. Doherty, president, Carnegie Institute of Technology, was elected chairman; Harry T. Woolson, executive engineer, the Chrysler Corporation, vice-chairman; George T. Seabury, Secretary of the American Society of Civil Engineers, secretary; and H. H. Henline, Secretary of the American Institute of Electrical Engineers, Assistant Secretary. The other officers elected: A. A. Potter, chairman, Committee on Engineering Schools; Charles F. Scott, chairman, Committee on Professional Recognition; R. L. Sackett, chairman, Committee on Student Selection and Guidance; S. D. Kirkpatrick, chairman, Committee on Professional Training; and E. R. Needles, chairman, Ways and Means Committee.

By unanimous vote of the Council, the Engineering Institute of Canada became the eighth participating body of E. C. P. D.

The Committee on Engineering Schools, whose principal function has been the accrediting of curricula, reported as of October 20, 1939, curricula to the number of 433 had been accredited unconditionally, 82 for a limited period, and 172 had not been accredited. During 1939–1940 visits were made to 22 institutions for the purpose of reinspecting 70 curricula on the accredited list, and 17 institutions were visited in order to appraise 32 curricula not on the accredited list. As a result of the year's work and of actions taken on October 24, 1940, the record now stands as follows: Total curricula submitted, including reinspections, 791; accredited unprovisionally, 457; accredited provisionally, 83; not accredited, 164; reinspections resulting in no change in status, 82; action pending, 5.

NEW MEMBERS

Associate institutional membership,
ARKANSAS POLYTECHNIC COLLEGE, Russellville, Ark.

ASHTON, MERTON E., Associate Professor of Civil Engineering, Norwich University, Northfield, Vt. A. D. Taylor, A. E. Winslow.

BESSEY, WM. H., Instructor in Physics, North Carolina State College, Raleigh, N. C. G. W. Petrie, F. W. Lancaster.

BUNN, JAMES C., Instructor in Mathematics, North Carolina State College, Raleigh, N. C. H. M. Nahikian, H. V. Park.

COOKE, HENRY C., Instructor in Mathematics, North Carolina State College, Raleigh, N. C. H. M. Nahikian, H. V. Park.

CROUCH, JOEL E., Instructor in Industrial Engineering, Pennsylvania State College, State College, Pa. M. M. Babcock, R. A. Hussey.

DRENICK, RUDOLPH F., Instructor in Mathematics, Villanova College, Villanova, Pa. J. S. Morehouse, W. A. Slavin.

GABA, MEYER G., Professor of Mathematics, University of Nebraska, Lincoln, Nebr. W. C. Brenke, O. J. Ferguson.

GALLEN, JOHN J., Instructor in Civil Engineering, Villanova College, Villanova, Pa. J. A. Oakley, J. S. Morehouse.

GELBART, ABE, Instructor in Mathematics, North Carolina State College, Raleigh, N. C. H. M. Nahikian, H. V. Park.

GORMAN, WM. M., Instructor in Mechanical Engineering, Villanova College, Villanova, Pa. J. S. Morehouse, H. S. Bueche.

HAGERTY, WM. WALSH, Instructor in Mechanical Engineering, Villanova College, Villanova, Pa. J. S. Morehouse, J. A. Oakey.

HEBRANK, EUGENE F., Instructor in Industrial Engineering and Engineering Drawing, Texas Technological College, Lubbock, Texas. O. A. St. Clair, O. V. Adams.

HIGGINS, THOMAS J., Instructor in Electrical Engineering, Purdue University, Lafayette, Ind. G. V. Mueller, R. P. Siskind.

LAKE, ROBERT E., Instructor in Mathematics, North Carolina State College, Raleigh, N. C. C. G. Mumford, H. M. Nahikian.

LEE, ROLAND L., Professor and Head, Textile Engineering, Texas Technological College, Lubbock, Texas. O. V. Adams, O. A. St. Clair.

LEVINE, JACK, Associate Professor of Mathematics, North Carolina State College, Raleigh, N. C. H. M. Nahikian, H. V. Park.

LIMACHER, F. J., Instructor in Chemical Engineering, Villanova College, Villanova, Pa. J. S. Morehouse, Emil Amelotti.

MASSEY, JOE T., Instructor in Mechanical Engineering, North Carolina State College, Raleigh, N. C. G. Wallace Smith, N. W. Conner.

MILES, ERNEST P., Instructor in Mathematics, North Carolina State College, Raleigh, N. C. H. M. Nahikian, H. A. Fisher.

OWEN, HALSEY F., Assistant Professor of Shop Practice, Purdue University, Lafayette, Ind. C. W. Beese, J. N. Arnold.

ROGERS, H. BARRETT, Assistant Professor of Industrial Engineering, Purdue University, Lafayette, Ind. C. W. Beese, J. N. Arnold.

WATANABE, KENICHI, Instructor in Mathematics and Engineering, University of Hawaii, Honolulu, T. H. C. B. Andrews, A. R. Keller.

WEYSSER, JOHN L. G., Assistant Professor of Mining Engineering, University of Illinois, Urbana, Ill. W. R. Chedsey, M. L. Enger.

WILCOX, HOWARD G., Head, School of Mines, Professor of Geology and Mining, University of Alaska, College, Alaska. W. E. Duckering, F. L. Bishop.

COLLEGE NOTES

University of Southern California.—Philip S. Biegler gave up the Deanship in order to confine his work to the Department of Electrical Engineering, and Robert E. Vivian, who has been Head of the Department of Chemical Engineering for the last three years, now becomes Acting Dean of the College of Engineering and Professor of Chemical Engineering. Dean Vivian, who received his doctor's degree in engineering at Columbia, has had long experience in chemical engineering work with the General Chemical Company and more recently with the Metals Disintegrating Company at Elizabeth, New Jersey. He is a member of the American Chemical Society, the American Institute of Chemical Engineers, Sigma Xi, and many other scientific societies. Herbert Waterman has been appointed Lecturer in Chemical Engineering.

We are moving the last of the laboratories into the new Engineering Building which has been occupied for the past year.

Cornell University.—Frederick G. Switzer, professor of mechanics and hydraulic engineering and head of the Department of Mechanics in the Sibley School of Mechanical Engineering, has resigned to become a division engineer with the New York City Board of Water Supply.

James N. Goodier has been appointed to succeed Professor Switzer as head of the Department of Mechanics. Professor Goodier joined the faculty in 1938 as professor of mechanics, and holds A.B., M.A., and Ph.D. degrees from Cambridge University and Sc.D. degree from the University of Michigan. He won the Rex Moir, Ricardo, and Winbolt prizes at Cambridge, and was supervisor of engineering students in Downing College there from 1927 to 1929. From 1931 to 1938 he was research fellow in applied mechanics at the Ontario Research Foundation in Toronto, Canada, and in 1937–38 was also special lecturer in civil engineering at the University of Toronto. He has published numerous technical articles in engineering journals.

Also announced was the appointment of Dr. Arthur S. Adams, assistant to the dean, as professor of mechanics. Dr. Adams is secretary of the Engineering Experiment Station and supervisor of extramural courses in airplane design in Buffalo.

The Department of Mathematics of the Engineering School of **Fenn College** announces the following appointments:

Howard Alexander, M.A., University of Toronto, Ph.D. Princeton University. Dr. Alexander has had teaching experience at the University of Toronto and Lehigh University.

Everett Hurlburt, A.M. Harvard University, Ph.D. Ohio State University. Dr. Hurlburt has had previous teaching experience at Fenn College and was more recently a Graduate Assistant in Physics at the Ohio State University.

Karl Kelly, M.S. University of Chicago, A.M. Transylvania College. Mr. Kelly's previous teaching experience includes appointments at Colorado School of Mines, Bowling Green State College and Adelbert College of Western Reserve University.

Massachusetts Institute of Technology.—During the summer construction of an addition to the Internal Combustion Engine Laboratory has been started. This project was made possible by a gift from Alfred P. Sloan, Jr., and will permit the Institute to increase its work on aircraft engine design and production. The laboratory will have 10,000 square feet of floor space and should assure unification and expansion of research and provide for an increased number of students.

Extensive alterations have been made in the Guggenheim Laboratory in order to permit the training of more men in Aeronautical Engineering and Meteorology.

The Mineral Dressing Laboratories of the Department of Metallurgy have been rearranged and newly equipped.

Major innovations in recreational facilities include the opening of the new Alumni Swimming Pool and a reorganization of the library facilities of Walker Memorial.

Extensive space rearrangements have been made in the present buildings to relieve congestion in the Department of Biology and Public Health providing for an additional half dozen research units and a machine shop. The Food Technology Laboratories have been enlarged as have those of Biological Engineering and Biophysics.

J. W. M. Bunker of the Department of Biology and Public Health has been appointed Dean of the Graduate School to replace H. M. Goodwin who retired with the close of the past academic year.

O. C. Shepard of the University of California will be associated with the staff of the Department of Metallurgy in exchange with Professor E. E. Bugbee.

Richard von Mises is to be a special lecturer on Fluid Mechanics in the Department of Mechanical Engineering.

Roland D. Parks, authority on mining economics, has been appointed an Assistant Professor of Geology.

E. N. Harvey, physiologist, biochemist and biophysicist of

Princeton University, will spend part of his time at the Institute as a lecturer and consultant.

J. R. Loofbourow, formerly of the staff of the basic science research laboratory at the University of Cincinnati, begins his duties as Associate Professor of Biophysics.

Space changes already mentioned in the Department of Aeronautical Engineering have made it possible to increase the number of students in Meteorology from 30 to 100. A new special course in coöperation with the U. S. Army Air Corps has been started.

SUMMER SESSION CONFERENCE ON ENGLISH AND SPEECH

The University of Michigan, coöperating with the Committee on English of the S. P. E. E., is arranging a special summer session conference on English and speech for teachers of engineering students who may be able to attend the S. P. E. E. convention at Ann Arbor, June 23–27, 1941. A period of three weeks, immediately following the convention, will be devoted to conferences on composition, literature, and speech under the leadership of prominent educators in these fields. This will be a non-credit course with a registration fee of $10. Numerous credit courses, however, will be available to those who may wish to carry them.

Details of the program will be announced as soon as they are determined. We are anxious, however, to have the project come to the immediate attention of the teachers of these subjects, and we ask that the program be called to their attention by members of this Society wherever possible.

O. J. Ferguson, *Chairman*,
Committee on English

BOOK REVIEWS

Electrical Communication. By Arthur Lemuel Albert. Second Edition. John Wiley and Sons, Inc. 534 pages. Price $5.00.

In the revision of "Electrical Communication" Professor Albert has retained in general the same titles for the 15 chapter headings as in the first edition, but he has changed and brought up to the minute much of the material, as well as adding to the list of references at the end of each chapter.

The author has enlarged the usefulness of the text greatly by the addition of "Suggested Assignments" or problems at the end of each chapter.

The chapter headings with the number of "Suggested Assignments" at the end of the chapter are:

1. The History of Electrical Communication. (0)
2. Sound and Acoustics. (6)
3. Speech and Hearing. (8)
4. Electrical Fundamentals and Communication. (10)
5. Transmitters and Microphones. (10)
6. Receivers and Loud Speakers. (5)
7. Exchange and Toll Service and Systems. (5)
8. Telegraph Systems. (5)
9. Telephone Transmission Theory. (10)
10. Networks and Electric Wave Filters. (10)
11. Inductively Loaded Circuits. (5)
12. Inductive Interference and Plant Protection. (10)
13. Electronics and Vacuum Tubes. (15)
14. Electronic Applications in Wire Communication. (8)
15. Wireless Communication. (8)

Some of the outstanding additions are Noise Measurements in Chapter 3, Coaxial Cables in Chapter 9 and Crystal Filters in Chapter 10. Chapters 13 to 15 have been revised to contain nearly two times the original material.

Fundamentals of Electricity and Electromagnetism. By Vernon Andrew Suydam. D. Van Nostrand Co., Inc. 690 pages.

In "Fundamentals of Electricity and Electromagnetism" the author has developed a text that is intended for use in a study of

the basic principles of electricity and electromagnetism immediately following a course in general physics.

The author assumes the student has finished a course in calculus but not differential equations, although differential equations are used throughout the book the various methods of solution of these equations are developed as they are needed.

The text contains 25 chapters which are divided into 344 sections. The headings of the chapters as well as the number of problems at the end of each chapter are:

1. Electrostatics. (25)
2. Capacitance, Electrostatic Energy, and Images. (29)
3. Dielectric Theory and Behavior. (6)
4. Magnetostatics. (23)
5. Terrestrial Magnetism. (2)
6. Direct Current Circuits. (14)
7. Metallic Conduction and Resistance. (13)
8. Electrolytic Conduction. (10)
9. Thermoelectric Effects. (4)
10. Electronic Emission. (0)
11. Electromagnetics. (13)
12. Induced Electromotive Forces. (2)
13. Electric Instruments Depending on Magnetic Fields. (6)
14. The Magnetic Circuit. (9)
15. Moving Charges and the Electromagnetic Field. (0)
16. Atomic Constituents. Moving Charges in Magnetic and Electric Felds. (0)
17. Transient Currents. (12)
18. Alternating Currents. (9)
19. Vector Treatment of Alternating Currents. (17)
20. Complex Quantities. (7)
21. Complex Quantity Method in Alternating Currents. (12)
22. Alternating Current Bridges. (0)
23. Electric Oscillations and Electric Waves on Wires. (0)
24. The Electromagnetic Field. (0)
25. Thermionic Electron Tubes and Their Use. (0)

The material is very clearly presented and is sufficient for a three-hour course for two semesters for either Electrical Engineering or Physics Major students.

PHILIP E. RUSH

Practical Mechanics and Strength of Materials. BY C. W. LEIGH AND F. W. MANGOLD. Third Edition. McGraw-Hill. $3.00.

This is a revision of a text which is perhaps not as well known as it should be. The book was originally written to be used in the

evening classes of a metropolitan engineering school, but would lend itself to use in any technical college.

Any student with a good foundation in high school mathematics should have no difficulty in understanding the material presented. The material has been chosen for the practical man who has a particular reason for studying the mechanics of materials other than as a required subject for a degree.

Unlike most courses which treat mechanics and strength of materials as separate subjects, this text combines the two in logical sequence. The teacher who has run into the difficulty of keeping discussions of strength of materials out of lectures on statics will welcome this procedure. Only those phases of mechanics are taken up which are necessary to the understanding of the action of materials. Each branch of strength of materials has been preceded by the appropriate chapter on mechanics. For example: Beams, Columns, and Torsion are taken up only after studying Concurrent Forces, Moments, Center of Gravity, and Moment of Inertia.

The discussion of each subject is followed by examples of a practical nature worked out step by step. Answers are given for most of the problems to be worked by the student. Abbreviated tables of properties of structural sections are given, but the student is encouraged to use the standard structural handbooks, in order to become familiar with their use.

This book would be an excellent review course for the practicing engineer who feels that he wants to brush up on some phases of the subject. It would probably be a valuable reference also for that student in strength of materials who has forgotten his course in statics.

WM. T. HOOPER, JR.

A Handbook of English in Engineering Usage. By A. C. HOWELL. Second Edition. New York, John Wiley & Sons, 1940. x + 433 pp., 7½ × 5 in., cloth, $2.50.

This second edition of Professor Howell's very popular "Handbook of English in Engineering Usage" has been increased by a full third of its original length. The fundamental principles on which the first edition was constructed, the order of the subjects dealt with, and the generally handy format of the book have been preserved. This is as it should be; for a book of this kind, once it has been found as serviceable as this has, should not be tampered with except in details where long use and practice suggest possible improvements.

Several details on which common agreement seemed impossible of attainment in 1930, when the first edition appeared, have been

modified. One of the features of the first edition that sometimes provoked difficulties, both for the student as well as for the instructor, was the lack of uniformity between the list of abbreviations as prepared by Professor Howell from the several lists then supplied by the several professional societies and associations, on the one hand, and the variation in forms used by professional engineers and authors of text-books in engineering, on the other. Since then, greater unanimity regarding what constitutes standard form has been secured among the professional societies; Professor Howell has availed himself of the progressive advance in this respect: the new list of abbreviations is admirable.

Minor matters of form, including inconsistencies and typographical errors, that were noted by the author and other professors of English for engineers who used the volume during the decade since its first publication, have been adjusted.

The chief feature of the book, its practicability, has been preserved, and in many cases enhanced, chiefly by the addition of numerous examples illustrating technical principles as these are applied in actual cases. Indeed, the most noteworthy feature of the book is the excellence of the illustrative material, all of which is directly related to the student's experience and needs. The extensive *exempla* given in connection with the various and, to the student, often confusing parts of formal engineering reports are particularly valuable. For example, the distinction between an abstract and an epitome, often a source of perplexity for inexperienced engineers, is rendered clear by reproductions from professional published reports. Equally valuable are the illustrations of proper forms to be employed in documented reports, involving the use of footnotes and bibliography.

All in all, the book combines, in the nicest degree, economy with practicability, in such a manner as to win even wider acceptance than did the first edition among teachers, students, and professional engineers.

HENRY A. POCHMANN

G-E Campus News

FROZEN LIGHT

THE "late" Baron Munchausen was accredited (by himself) with incredible feats among which was freezing the ring of a bell. Recently, however, General Electric research scientists at Schenectady, N. Y., outdid the Baron by freezing light.

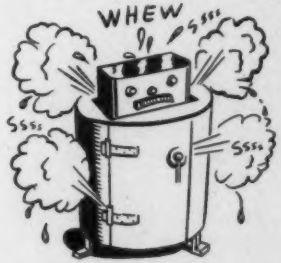
In producing this frozen light, G-E scientists submerged fluorescent plates in a large thermos bottle of liquid air with a temperature of 320 degrees below zero. The bottle and the plates were then bombarded by x-rays, exciting the atoms of fluorescent material on the plates literally freezing them stiff. When the plates were removed and allowed to warm up, they glowed with all the colors of the rainbow.

A "bottle" of frozen light was sent to East Orange, N. J., where it was unveiled in connection with the ceremonies marking the premiere of the movie, "Edison, The Man."

RADIO TURKISH BATH

RATS and moisture seem to be the two chief enemies of radio sets in the tropics. A letter from the Belgian Congo testifies to the rats; the evidence for the humidity is already ample. Except for recommending traps, there is little the General Electric Company can do about the rats, but the study of humidity is right up its alley since G-E engineers at Bridgeport, Conn., have built a humidity chamber capable of reproducing the weather conditions of the tropics.

Lamps under water tanks provide humidity by vaporization, and generate enough heat to maintain a temperature of about 100 F. Humidity and temperature are controlled by time clocks outside the sealed chamber, while uniform weather conditions are maintained in the chamber by circulating fans.



Radio receivers placed in this room are continuously subjected to conditions far more severe than those of the tropics until failures occur in the sets. In this way, young engineering college graduates enrolled in the G-E Test Course gather data which contribute to the improvement of radio, not only in the tropics, but everywhere radios are used.

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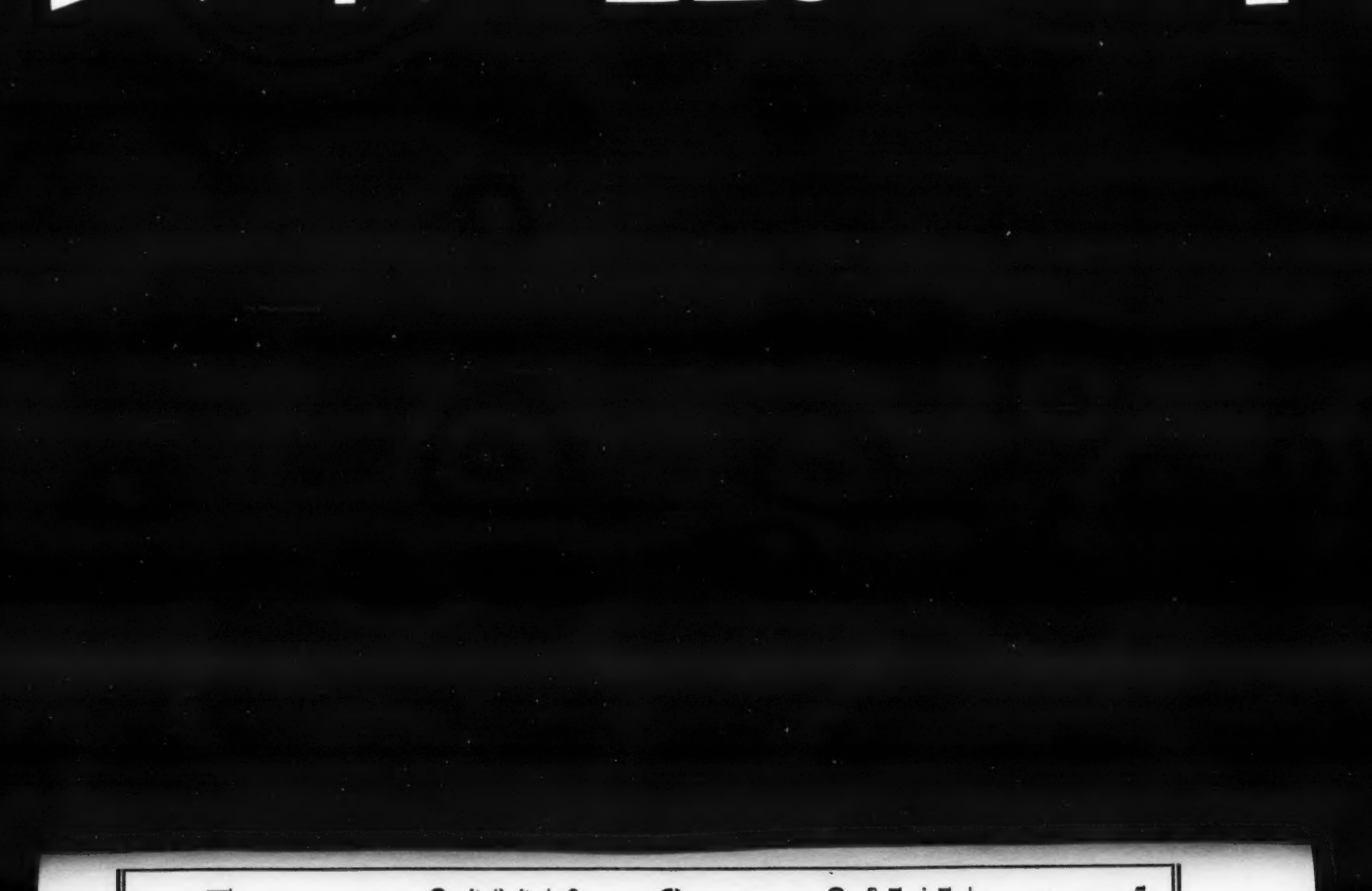
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